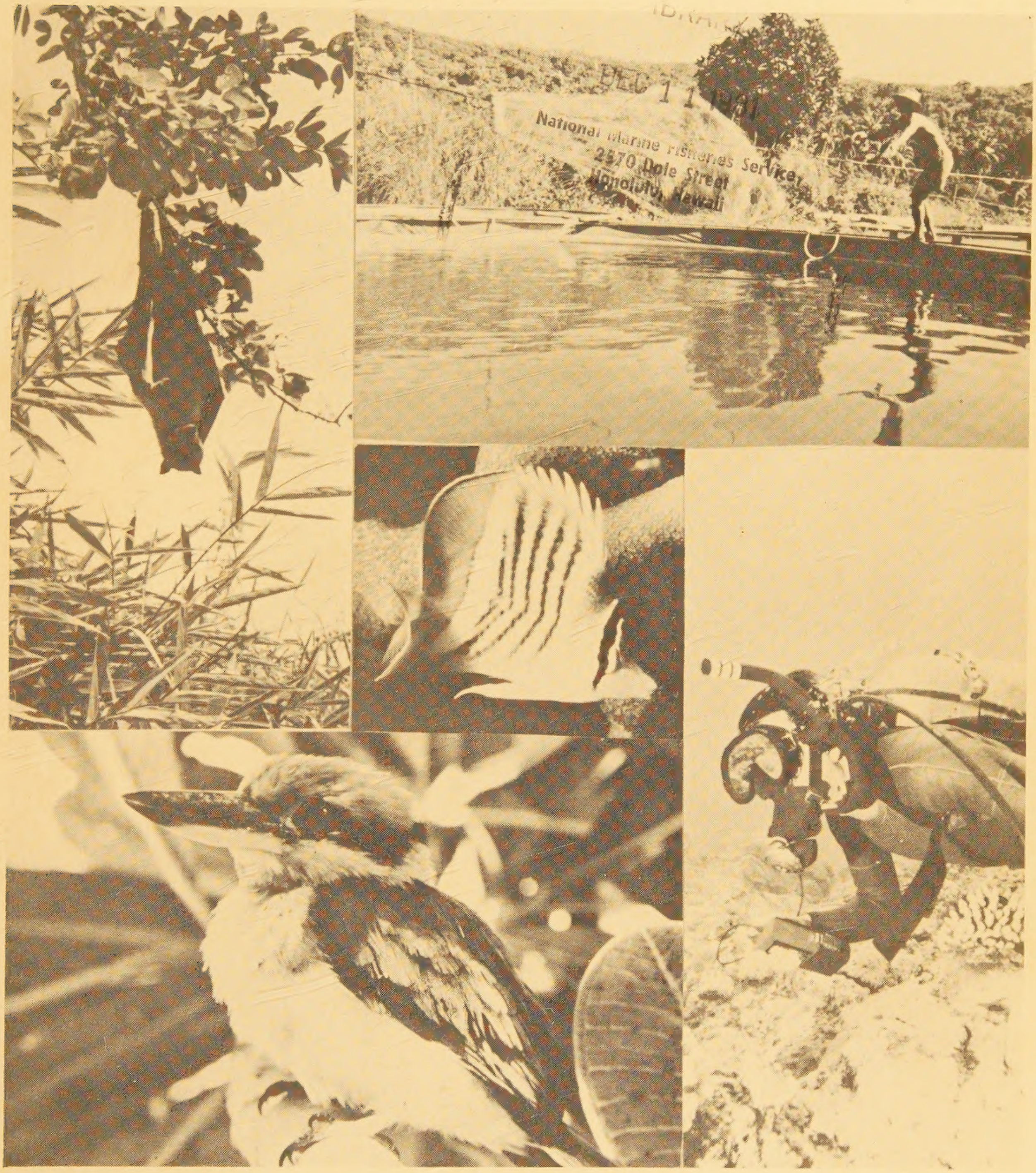
AQUATIC AND WILDLIFE RESOURCES



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OCTOBER 1, 1979 - SEPTEMBER 30, 1980
FY 1980

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ANNUAL REPORT
Fiscal Year 1980

GUAM
AQUATIC & WILDLIFE RESOURCES DIVISION
Harry T. Kami, Chief

DEPARTMENT OF AGRICULTURE
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Edited By:
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PERIOD COVERED:
October 1, 1979 to September 30, 1980

ACKNOWLEDGEMENTS

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All fishermen and fish weir operators who have cooperated with fishery data collection.

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All hunters who have cooperated with wildlife data collection by submitting hunter report cards.

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The Commander of the Marianas Section, U.S. Coast Guard.

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GUAM FISHERIES INVESTIGATIONS
PROJECT FW-2R-17
Federal Aid in Sport Fish Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam PROJECT NO.: FW-2R-17

PROJECT TITLE: Guam Fish and Wildlife Investigations

STUDY TITLE: Creel Census and Fish Population Studies (F-I)

PERIOD COVERED: October 1, 1979 to September 30, 1980

This study consists of several separate jobs, each of which will be reported under the job title. The jobs are: offshore creel census, inshore creel census, data processing for creel census, compilation of a checklist of fishes of Guam, reef fish population investigations and preparation of study report. A special report on the census taken during the Fourth Annual Marianas Fishing Derby is also included in this study. The data from the derby was collected by Division personnel and represents the result of intensive offshore fishing pressure over a three day period. Also included is a harvest report of the FY 80, licensed Fish Weirs.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 1

JOB TITLE: Offshore Creel Census

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Fishery biologists censused fish landings for four days each month at Agana Boat Basin and two days each month at Merizo Pier. The offshore fishing effort is divided among three basic methods: trolling, bottom fishing and spearfishing. The estimated total catches for each method this fiscal year were 46,531, 2,867 and 775 kilograms, respectively. The total estimated catch for all three methods combined was 50,173 kilograms.

The above figures applied only to the boats fishing from the Agana Boat Basin and Merizo. In addition, there were boats that consistently fished from such locations as Apra Harbor, Agat, Umatac and the Ylig River. Boats from the Boat Basin and Merizo Pier averaged about 4.2 fishing trips per day (1,541 total) for the entire year. Our best estimate of the number of boats from the other locations combined is about another 4 trips per day. Doubling the annual catch figures from Boat Basin and Merizo Pier gives an island-wide total offshore harvest of 100,356 kilograms.

BACKGROUND

Effective management of the island's fishery resources requires accumulating data on fishing pressure, types of fishing methods and annual harvest. To this end, the Division of Aquatic & Wildlife Resources has been conducting offshore fishing interviews with fishermen for more than sixteen years.

OBJECTIVES

I. To monitor trends in types and results of different fishing methods, areas fished, and types and amounts of each species taken for both inshore and offshore fishing activities. This information will be made available to the fishermen so that they may use it to improve their catch.

II. To chart variations in standing crop, species composition, and/or distribution patterns for various areas, and to determine if these variations occur in a seasonal or otherwise predictable manner.

III. To make annual estimates of the total fish catch for Guam.

IV. To create a table of length/weight conversion constants for Guam's popular inshore and offshore game fishes.

PROCEDURES

During FY 80, creel censuses were scheduled at the Agana Boat Basin at the rate of four censuses each month (two weekdays and one weekend or holiday). All creel census days were chosen by lottery at least one month in advance.

At the Agana Boat Basin, weekday censuses were conducted continuously from 1400 to 2100 hrs., and weekend censuses from 0600 to 2100 hrs. A study conducted in 1978 indicated that about 90% of the boats fishing on any particular day would be included in a census covering those hours. At the Merizo Pier, censuses were conducted continuously from 1500 to 2100 hrs. on weekdays, and from about 1300 to 2100 hrs. on weekends. All fishing parties either leaving or returning during a census were interviewed. In addition to the regular creel census program, AWR has been conducting a creel census and household interview survey under a subcontract from Statistics and Marketing Services Inc. (SMS), a Honolulu based firm contracted by the National Marine Fisheries Service (NMFS) to conduct the Pacific portion of a nation-wide recreational fishing survey.

There are three major fishing methods employed by offshore anglers on Guam. The most widely practiced of these is multiple-line surface trolling from small, recreational boats, usually less than 30 feet in length. The other two methods are deep-bottom fishing (usually at depths from 100 to 200 fathoms), and nearshore spearfishing at locations which are generally inaccessible to people without the use of boats.

RESULTS

The estimated monthly and annual catch and effort values are presented in Table 1. The monthly catch and effort estimates in Table 1 are derived from the formula:

$$(H/h)(X_h) + (W/w)(X_w) = E \;;$$

where H and W are the numbers of holidays and weekdays during the month; h and w are the numbers of holiday and weekday censuses; X is the recorded catch or effort from the censuses; and E is the monthly total estimate of catch or effort.

From Table 1, an estimated 4,323 persons spent 21,090 person-hours trolling an estimated 1.4 lines each during the 12 month report period.

The species composition of the trolling catch remained the same as in past years, and included representatives from the families Carangidae (jacks), Coryphaenidae (dorados), Istiophoridae (billfish), Scombridae (tunas), and Sphyraenidae (barracudas). Approximately 97 percent of the total annual harvest, estimated at 46.5 metric tons during FY 80, was accounted for by

Table 1. Monthly and Annual Effort, Catch and CPUE Estimates for Trolling Derived from Data Collected at the Agana Boat Basin and Merizo Pier During FY 80.

Month	No. Census Days	No. Boats	Trolling Hours	No. Persons	Person-Hours	No. Lines	Line-Hours	Catch (kg)	Catch/ Boat (kg)	Catch/ Person-hour (kg)	Catch/ Line-hour (kg)
1979 Oct.	6	148	774	510	2,643	584	8,389	2,305	15.6	0.87	0.27
Nov.	6	68	302	163	475	254	1,103	653	9.6	1.38	0.59
Dec.	5	120	602	433	1,884	516	2,563	1,271	10.6	0.67	0.49
1980 Jan.	6	132	657	353	657	410	2,070	1,999	15.1	1.14	0.96
Feb.	6	164	907	425	2,306	636	4,521	8,928	54.4	3.87	1.97
Mar.	6	143	935	344	2,273	563	3,772	5,974	41.8	2.63	1.58
Apr.	6	120	676	359	1,982	489	2,744	4,242	35.3	2.14	1.54
May	6	136	818	354	2,087	540	3,232	5,569	40.9	2.67	1.72
Jun.	6	109	414	314	1,191	393	1,479	1,068	9.8	0.89	0.72
*Jul.	4	92	408	239	1,058	290	1,286	2,333	25.4	2.20	1.82
Aug.	6	141	826	410	2,426	603	3,589	5,348	37.9	2.20	1.49
Sept.	6	168	849	419	2,108	653	3,291	6,841	40.7	3.20	2.08
TOTAL	69	1,541	8,170	4,323	21,090	5,931	38,039	46,531	30.2	2.20	1.22

* July 4-7 Marianas Fishing Derby data not included in monthly total.

five major species. By weight, these species were mahimahi (Coryphaena hippurus) which made up 40.6 percent of the total catch; skipjack tuna (Katsuwonus pelamis), 33 percent; yellowfin tuna (Thunnus albacares), 9.5 percent; billfish (Mikaira nigricans and Istiophorus platypteris, 8.1 percent; and wahoo (Acanthocybium solandri), 5.5 percent. The remaining 3 percent of the landings was composed of catches of barracuda (Sphyraena barracuda), rainbow runner (Elagatis bipinnulatus) and miscellaneous jacks.

The total trolling harvest for this report period was one metric ton less than that reported during the same time period during FY 79. Although catch per unit effort was almost double the FY 79 figures, the number of boats and anglers-participating in the FY 80 offshore trolling was approximately 30 percent less than in FY 79. The average catch per trolling hour in kilograms and the estimated number of trolling-hours by month is shown in Figure 1. The average catch per trolling hour for the year was estimated at 4.8 kg/hour. February showed the largest catch-per-unit-effort of 9.8 kg/trolling-hour as a result of the large mahimahi run during that time.

Most of the fish species caught by trolling are seasonal and primarily caught during their annual migrations past Guam. These trends are reflected in the cumulative monthly landings in Figure 2 and in individual monthly catch frequencies of the five major species shown in Figure 3. The frequency of landings in Figure 3 indicate a large aggregation of mahimahi around the island during January, February, March and April which is then replaced by skipjack tuna for the next five months. Billfish appear in the catches during the month of June through December, with catches of yellowfin and wahoo occurring throughout the year. Although the migrations may roughly follow the same seasonal pattern each year, there may be considerable fluctuations in the numbers and size of fish, and the time of migration.

BOTTOM FISHING

Table 2 presents a monthly breakdown of effort and catch estimates for FY 80. These estimates were derived from the same projection equation as presented for offshore trolling. The number of boats engaged in bottom fishing increased from 190 in FY 79 to 305 during the same time in FY 80, while the number of anglers increased from 583 to 738. The total catch, however declined in FY 80 to 2,867 kg from 3,552 kg in FY 79. Along with the decline in total bottomfish landings, there was a decline in mean catch/boat from 14.7 kg/boat to 9.4 kg/boat. The catch per line-hour increased to 0.89 kg in FY 80 from the FY 79 estimate of 0.66 kg/line-hour.

As last year, the most abundant species caught were lehi (Aphraeus rutilans), uku (Aprion virescens), onaga (Etelis carbunculus, ehu (Etelis marshi, kalikali (Pristipomoides auricilla) and gindai (Rooseveltia brighami), all of which belong to the family Lutjanidae (snappers). Other snappers, and representatives of the jack family Carangidae, contributed lesser amounts to the total harvest.

OFFSHORE UNDERWATER FISHING ACTIVITIES

Offshore underwater fishing activities include spearfishing and netting fish while SCUBA diving and snorkleling. Table 3 presents a quarterly and annual estimate of catch and effort in these activities. The quarterly

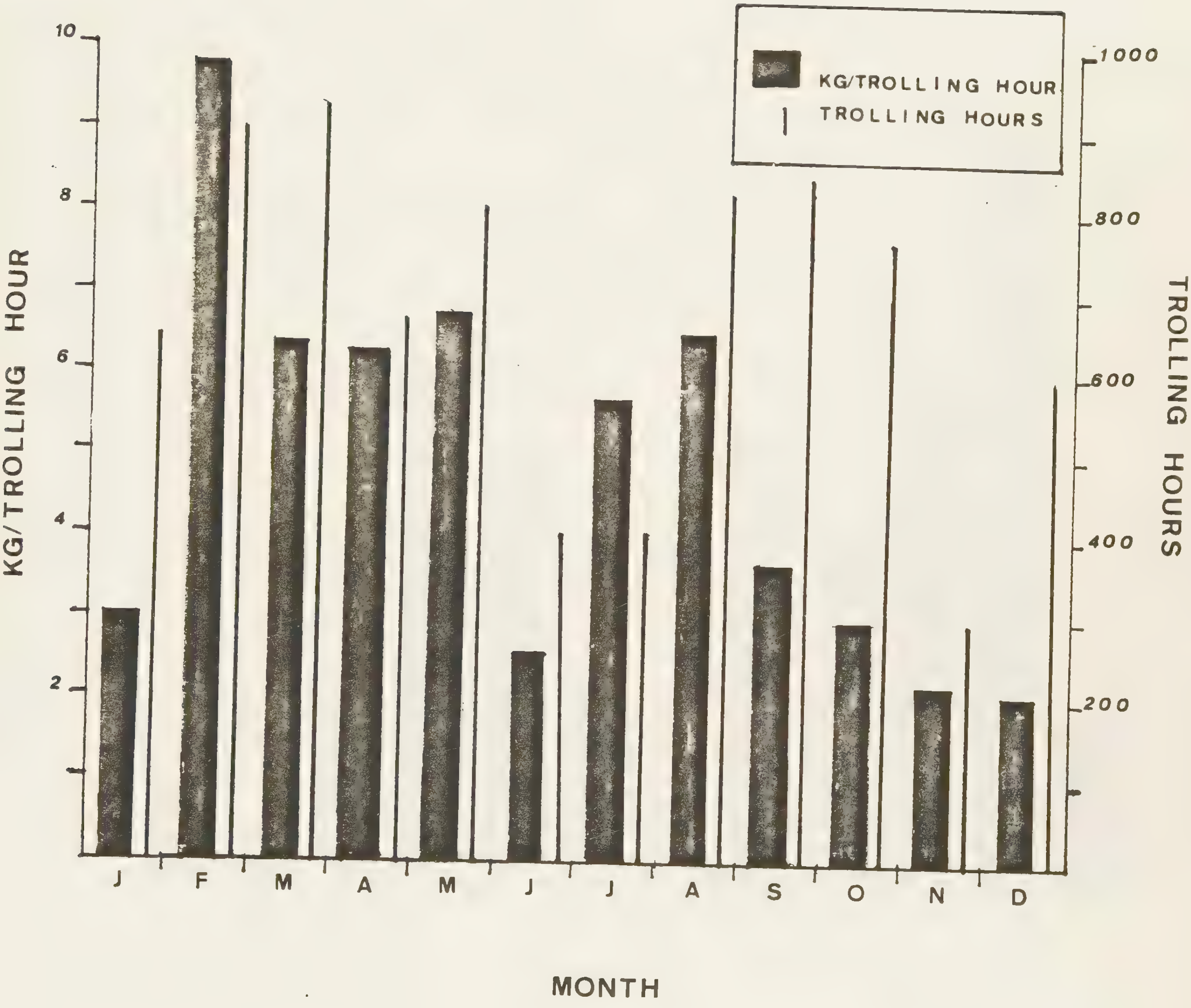


Figure 1. Estimated monthly catch by trolling hour and number of trolling hours by boats from Agana Boat Basin and Merizo Pier during FY 80.

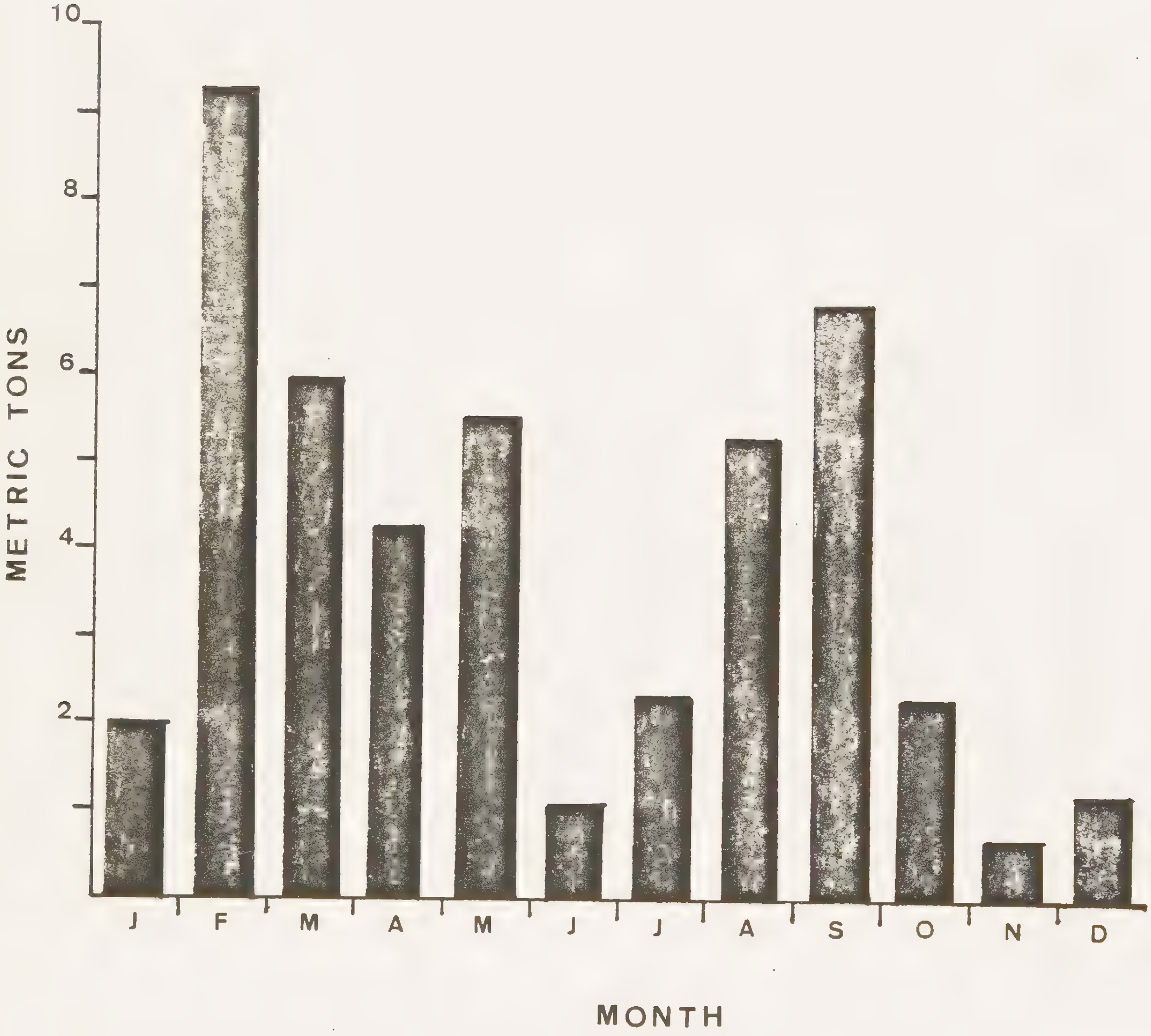
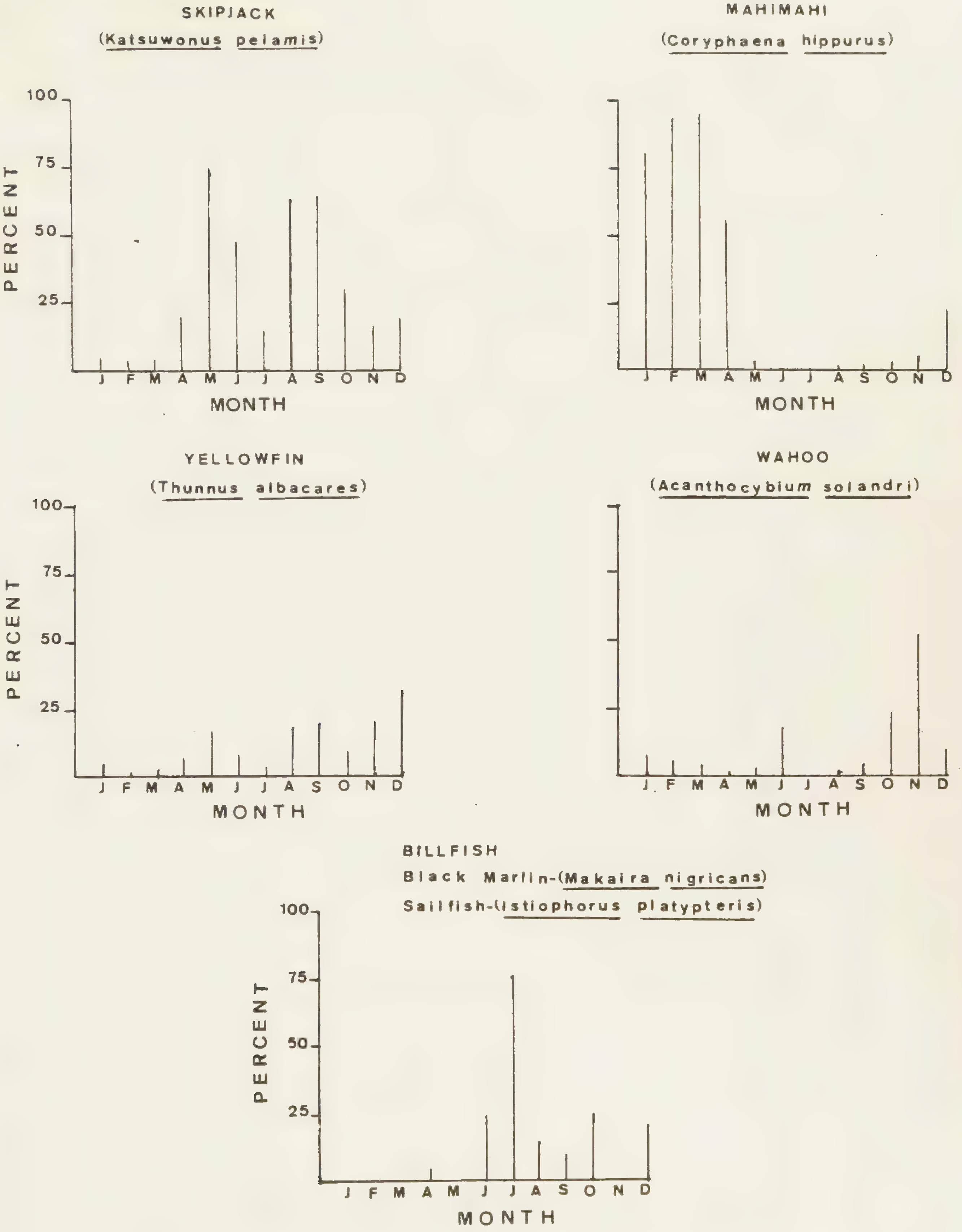


Figure 2. Estimated monthly trolling harvest landed at Agana Boat Basin and Merizo Pier during FY 80.



SKIPJACK
(*Katsuwonus pelamis*)

MAHIMAHI
(*Coryphaena hippurus*)

YELLOWFIN
(*Thunnus albacares*)

WAHOO
(*Acanthocybium solandri*)

BILLFISH
Black Marlin-(*Makaira nigricans*)
Sailfish-(*Istiophorus platypteris*)

Figure 3. Percent by weight of major species landed at Agana Boat Basin and Merizo Pier by month during FY '80.

Table 2. Monthly and Annual Effort, Catch and CPUE Estimates for Bottom Fishing from Data Collected at the Agana Boat Basin and Merizo Pier During FY 80.

	Month	No. Census Days	No. Boats	Fishing Hours	No. Persons	No. Lines	Line Hours	Catch (kg)	Catch/ Boat(kg)	Catch/ Line-Hour kg
1979	Oct.	6	53	188	158	136	481	282	5.3	0.58
	Nov.	6	40	99	90	90	223	108	2.7	0.48
	Dec.	5	32	182	71	71	404	261	8.1	0.64
1980	Jan.	6	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
	Feb.	6	7	54	7	7	54	98	14.0	1.82
	Mar.	6	10	57	21	21	114	32	3.2	0.28
	Apr.	6	10	27	25	25	56	25	2.5	0.44
	May	6	31	146	78	58	260	108	3.5	0.42
	Jun.	6	17	66	44	41	164	117	6.9	0.71
	Jul.	4	62	432	140	140	975	1,314	21.2	1.35
	Aug.	6	27	137	70	70	347	381	14.1	1.10
	Sept.	6	16	62	34	28	126	141	8.8	1.12
TOTAL		69	305	1,447	738	687	3,204	2,867	9.4	0.89

Table 3. Quarterly and Annual Estimates of Effort, Catch, and CPUE for Offshore Underwater Fishing Activities Derived from Data Collected at the Agana Boat Basin and Merizo Pier during FY 80.

Quarter	No. Census Days	No. Boats	Boat Hours	No. Persons	Person-Hours	Quarterly Catch (kg)	Catch/ Boat (kg)	Catch/Person Hours (kg)
1979								
October November December	17	26	37	75	111	26	1.0	0.24
1980								
January February March	18	3	10	9	32	28	9.3	0.88
April May June	18	47	125	155	406	476	10.1	1.17
July August September	16	37	108	124	390	225	6.1	0.58
TOTAL	69	113	280	363	939	775	6.7	0.82

estimates were derived from the following formula:

$$(h/_{h})(A) + (W/_{w})(B) = E \;;$$

where H and W are the three month total of holidays and weekdays; and h and w are the three month total numbers of holiday and weekday censuses; A and B represent the total catch or effort for that three month period for holidays or weekdays; and E is the derived three month estimate.

The major species of fish included in the catch belong to the families Acanthuridae (surgeon fishes), Carangidae (jacks), Holocentridae (squirrel fishes), Kyphosidae (rudder fishes), Labridae (wrasses), Serranidae (groupers), and Scaridae (parrot fishes). The top shell (*Trochus niloticus*), lobster, octopus and a few *Tridacna* clams contributed a small amount to the total underwater harvest.

RECOMMENDATIONS

The Western Pacific Fisheries Regional Management Council has proposed a region-wide program of reviewing and coding all past creel census data for incorporation into the Fisheries Information Network (FIN). Guam will participate in this program. The Creel Census Program should be continued on a quarterly basis, and modifications resulting from the region-wide program should be incorporated.

Report prepared by Donald Morris

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 2

JOB TITLE: Inshore Creel Census

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Inshore creel census interviews were conducted monthly from October, 1979 to September, 1980. Three shoreline routes were censused twice per month. An estimated total of 17,210 kg of finfish was caught. Hook and line fishing was the most popular method, accounting for over 50% of the gear-hours. Surround netting yielded over 66% of the total catch. Other major inshore fishing methods include cast netting, gill netting and spear fishing.

BACKGROUND

Effective management of the island's fishery resoures requires accumulating data on fishing pressure, types of fishing methods and annual harvest. To this end, the Division of Aquatic and Wildlife Resources has been conducting inshore fishing interviews with fishermen for the last sixteen years.

OBJECTIVES

I. To monitor trends in types and results of different fishing methods, areas fished, and types and amounts of each species taken for both inshore and offshore fishing activities. This information will be made available to the fishermen so that they may use it to improve catch.

II. To chart variations in standing crop, species composition, and/or distribution patterns for various areas, and to determine if these variations occur in a seasonal or otherwise predictable manner.

III. To make annual estimates of the total fish catch for Guam.

IV. To create a table of length/weight conversion constants for Guam's popular inshore and offshore game fishes.

PROCEDURES

Inshore creel census interviews were conducted monthly during the 1980 report period (October 1979 - September 1980). Censuses were taken along three shoreline routes (Figure 1), which include the areas of heaviest fishing pressure on Guam. Each route was censused twice per month (once on a weekday and once on a holiday), except when prevented by weather conditions or personnel shortages. Dates were chosen by lottery, and no two routes were censused on the same day.

RESULTS

The major inshore fishing methods include hook and line fishing, cast netting, gill netting, surround netting, and spearfishing. In addition, octopi, lobsters, crabs, and shellfish were harvested by hand or with hooks and short spears.

Actual censused data, for each fishing method is presented in Tables 1a - 5a. Tables 1b - 5b present expanded fishing data and catch-per-unit-effort values based upon estimates derived from the actual census data. Estimated values were obtained by computing mean catch and effort values for both weekdays and holidays, and then multiplying these values by the number of weekdays and holidays, respectively, for each month. Table 6 summarizes the catch and effort data by fishing method for FY 80.

An estimated total of 17,210 kg of finfish was caught through the use of all five of the major inshore fishing methods in FY 80 (Table 6). This catch resulted from a total effort of 25,644 person-hours, or 21,091 gear-hours. Approximately 0.7 and 0.8 kg of fish were taken for each person-hour and gear-hour, respectively. Over 30 species of fish, from 13 families, were represented in the catch. However, surgeon fish (Acanthuridae), jacks (Carangidae), rabbit fish (Siganidae) and goat fish (Mullidae) were by far the most abundant.

As in previous years, hook and line fishing was the most popular method, accounting for 42.7% of the total person-hours and over 50% of the gear-hours. Success with hook and line gear, however, was found to be lower than that of any other method, averaging less than 0.2 kg per fishing-hour. This method produced 1,702 kg, or approximately 10% of the total yearly catch. The greatest effort and largest catches for hook and line fishing occurred in late summer and early fall (Figure 2).

Cast netting, a traditional method of fishing, accounted for approximately 15% of the total fishing effort and 9.4% of total catch (Table 6). As this method of fishing is strongly affected by surf and weather conditions, the greatest effort occurred during the spring and summer months when conditions are most favorable (Figure 2). The catch-per-unit-effort for cast netting is comparable to those for gill netting and spearfishing.

The effort expended by anglers in gill netting was second only to that of hook and line fishing. Approximately 20% of the total persons and gear-hours was devoted to this method and 1821 kg of fish (10.6% of the total) were caught. Like cast netting, gill netting exhibited seasonal dfferences,

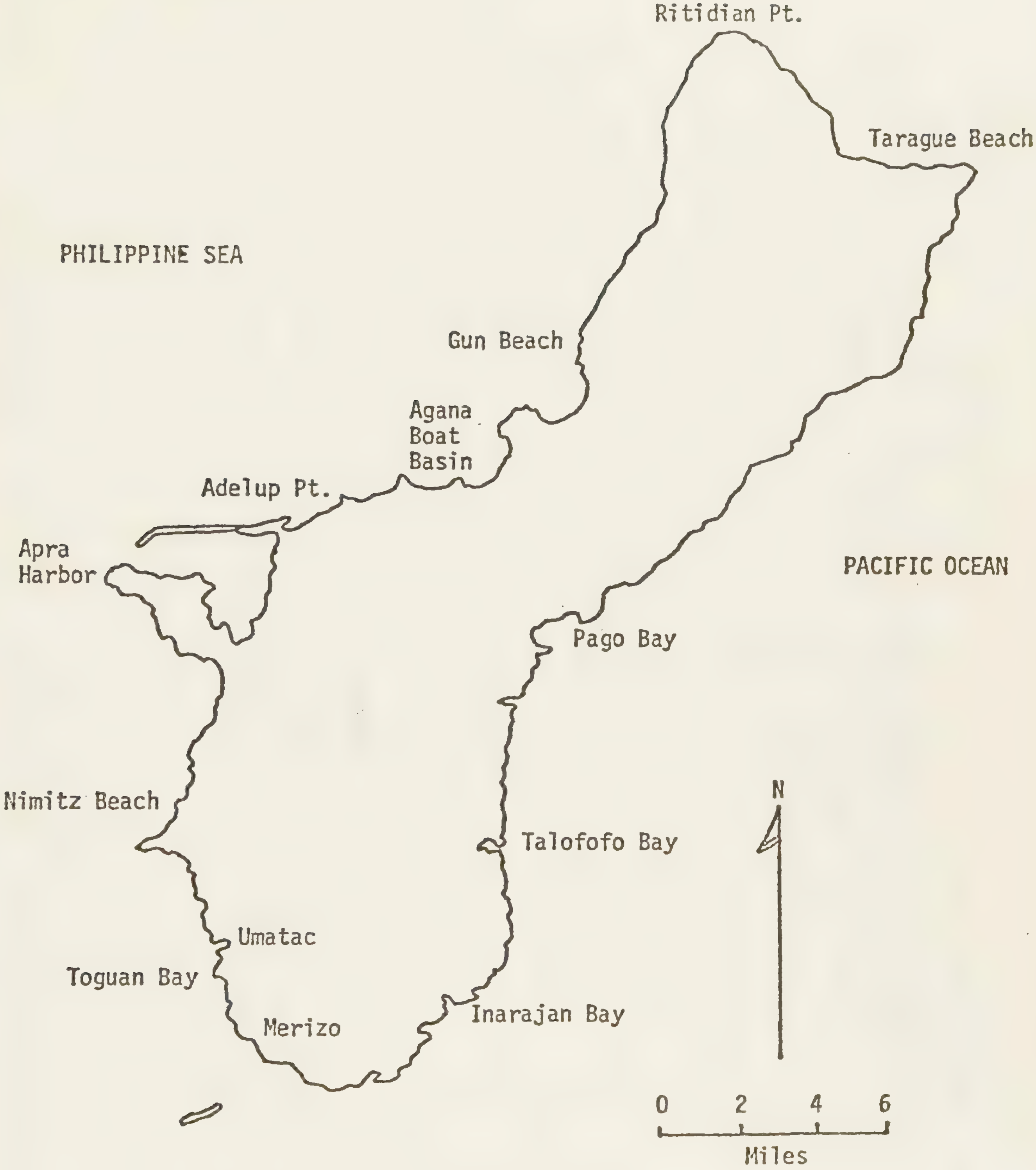

Ritidian Pt.
Taraque Beach
PHILIPPINE SEA
Gun Beach
Agana Boat Basin
Adelup Pt.
Apra Harbor
PACIFIC OCEAN
Pago Bay
Nimitz Beach
Talofofo Bay
N
Umatac
Toguan Bay
Inarajan Bay
Merizo
0
2
4
6
Miles

Figure 1. The island of Guam. The Inshore Fishing Census Regions are as follows: Region #1 - Gun Beach to Adelup Pt.
Region #2 - Adelup Pt. to Nimitz Beach
Region #3 - Toguan Bay to Pago Bay

Table 1a. Hook and line creel census data, summarized by month for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
October	72	208.88	73	217.48	43.94
November	62	160.0	67	146.04	16.33
December	21	38.28	21	38.28	4.81
January	48	133.44	46	129.36	9.33
February	34	45.56	33	47.66	3.45
March	29	79.64	32	99.34	3.63
April	12	22.96	12	22.96	1.9
May	26	44.08	26	46.78	4.43
June	28	55.34	24	61.04	7.15
July	38	147.0	36	137.16	27.9
August	50	139.56	50	146.46	16.81
September	27	59.4	30	81.3	6.94
TOTAL	447	1,134.14	450	1,173.9	146.62

Table 1b. Hook and line fishing data, expanded from Table 1a to yield total montly and annual estimates for fiscal year 1980.

FY 1980	Number of Person	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-h	Catch (Kg)
October	400	2,234	2,290	0.28	0.27	615
November	280	1,174	1,009	0.09	0.11	111
December	90	355	355	0.13	0.13	46
January	213	1,148	1,104	0.07	0.08	84
February	144	452	445	0.08	0.09	38
March	218	867	981	0.03	0.03	30
April	90	230	230	0.06	0.06	14
May	144	471	488	0.11	0.11	53
June	186	638	619	0.15	0.15	95
July	233	1,294	1,192	0.19	0.2	241
August	289	1,403	1,449	0.14	0.14	204
September	220	684	745	0.25	0.23	171
TOTAL	2,507	10,950	10,907	0.16	0.16	1,702

Table 2a. Cast net creel census data, summarized by month for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
October	2	4.6	1	2.3	0
November	5	7.56	5	7.56	4.17
December	10	15.8	10	15.8	3.8
January	6	3.7	6	3.7	0.44
February	5	4.5	5	4.5	3.0
March	5	10.3	4	8.3	4.4
April	22	32.9	16	20.3	24.58
May	24	61.2	21	58.2	7.23
June	21	42.36	13	26.28	12.2
July	30	74.54	22	58.58	32.75
August	22	46.0	17	33.7	25.64
September	11	10.8	8	9.9	5.43
TOTAL	163	314.3	128	249.1	123.64

Table 2b. Cast net fishing data, expanded from Table 2a to yield total monthly and annual estimates for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Gear-Hours	KG/P-H	Kg/G-H	Catch (Kg)
October	18	54	27	0	0	0
November	40	90	90	0.89	0.89	80
December	55	144	144	0.24	0.24	34
January	47	75	75	0.09	0.09	7
February	78	124	124	0.8	0.8	100
March	55	144	122	0.43	0.51	62
April	136	281	185	0.99	1.51	280
May	174	1,034	968	0.1	0.11	104
June	206	668	402	0.28	0.47	189
July	190	598	455	0.46	0.61	278
August	115	356	255	0.51	0.72	183
September	219	505	398	0.6	0.6	302
TOTAL	1,333	4,073	3,245	0.39	0.49	1,619

Table 3a. Gill net creel census data, summarized by month for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
October	2	0.6	1	0.3	1.0
November	5	10.0	17	57.0	11.96
December	2	2	1	1	0
January	10	18.2	6	8.8	2.21
February	7	11.4	3	4.8	28.94
March	23	203.8	8	88.65	25.36
April	21	53.08	10	19.36	14.8
May	18	59.0	19	83.1	32.27
June	19	51.06	43	152.54	19.5
July	39	96.36	43	95.84	29.8
August	39	83.4	21	43.8	19.46
September	8	25	5	15.3	15.66
TOTAL	193	629.9	177	570.5	200.96

Table 3b. Gill net fishing data, expanded from Table 3a to yield total monthly and annual estimates for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
October	18	5	3	1.67	3.34	9
November	25	58	288	1.19	0.24	69
December	22	88	44	0	0	0
January	68	262	146	0.11	0.2	30
February	62	143	67	1.82	3.86	260
March	107	655	288	0.12	0.26	76
April	91	334	138	0.25	0.59	83
May	90	444	520	0.55	0.47	244
June	110	497	1,435	0.39	0.13	192
July	234	953	911	0.32	0.34	307
August	244	1,329	910	0.21	0.30	275
September	52	314	224	0.88	1.2	276
TOTAL	1,123	5,082	4,974	0.36	0.37	1,821

Table 4a. Surround net creel census data, summarized by month for fiscal year 1980.

FY 1980	**Number of** Persons	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
October	-	-	-	-	-
November	12	28.0	2	5.0	231.21
December	-	-	-	-	-
Janaury	15	14.4	2	1.8	4.35
February	11	22.5	2	3.0	25.23
March	29	35.3	4	5.9	18.24
April	21	58.7	3	9.1	24.5
May	6	10.8	1	1.8	10.0
June	1	1.2	1	1.2	0.4
July	32	100.1	5	25.2	231.98
August	-	-	-	-	-
September	7	7.0	1	1.0	3.5
TOTAL	134	278.0	21	54.0	549.41

Table 4b. Surround net fishing data, expanded from Table 4a to yield total monthly and annual estimates for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/G-H	Catch (Kg)
October	-	-	-	-	-	-
November	120	640	140	8.26	37.76	5,286
December	-	-	-	-	-	-
January	68	216	27	0.3	2.42	65
February	50	175	28	1.12	6.92	196
March	87	481	64	0.52	3.91	250
April	94	556	78	0.42	3.05	233
May	60	210	35	0.92	5.52	193
June	21	25	25	0.33	0.33	8
July	529	1,947	398	2.64	12.89	5,137
August	-	-	-	-	-	-
September	63	63	9	0.5	3.5	32
TOTAL	1,092	4,313	804	2.64	14.2	11,400

Table 5a. Spearfishing creel census data, summarized by month for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Number Gear	Gear-Hours	Catch (Kg)
October	-	-	-	-	-
November	-	-	-	-	-
December	2	0.4	2	0.4	0
January	9	3.6	7	3.6	2.44
February	1	* 0	1	* 0	* 0
March	5	5.46	4	4.38	1.8
April	4	6.0	3	6.0	9.3
May	3	6.4	4	7.3	7.2
June	11	43.1	11	34.1	23.45
August	9	5.2	9	5.2	0.08
September	5	13.4	4	12.7	1.79
TOTAL	55	82.06	50	80.18	49.16

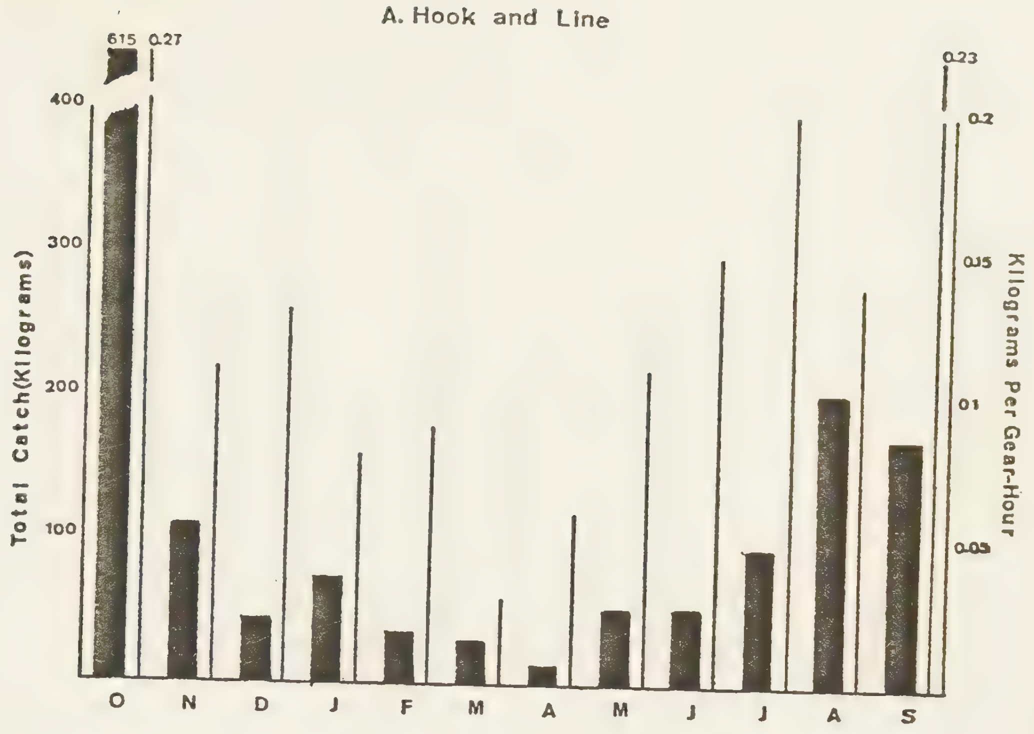
*Data Unobtainable

Table 5b. Spearfishing data, expanded from Table 5a to yield total monthly and annual estimates for fiscal year 1980.

FY 1980	Number of Persons	Person-Hours	Gear-Hours	Kg/P-H	Kg/7-H	Catch (Kg)
October	-	-	-	-	-	-
November	-	-	-	-	-	-
December	22	44	44	0	0	0
January	89	129	69	0.21	0.38	27
February	9	0	0	0	0	0
March	45	96	86	0.33	0.38	32
April	84	126	126	1.55	1.55	195
May	31	90	112	1.22	0.98	110
June	114	401	401	0.6	0.6	242
July	93	124	114	0.36	0.39	44
August	99	95	95	0.02	0.02	2
September	45	121	114	0.13	0.14	16
TOTAL	631	1,226	1,161	0.54	0.57	668

Table 6. Summary of Catch and Effort, by Method, For FY 80

Method	Person-Hours	%	Gear Hours	%	Kg/P-H	Kg/G-H	Catch	%
Hook and Line	10,950	42.7	10,907	51.7	0.16	0.16	1,702	9.9
Cast Net	4,073	15.9	3,245	15.4	0.39	0.49	1,619	9.4
Gill Net	5,082	19.8	4,974	23.6	0.36	0.37	1,821	10.6
Surround Net	4,313	16.8	804	3.8	2.64	14.2	11,400	66.2
Spearfishing	1,226	4.8	1,161	5.5	0.54	0.57	668	3.9
TOTAL	25,644	100	21,091	100	0.67	0.82	17,210	100



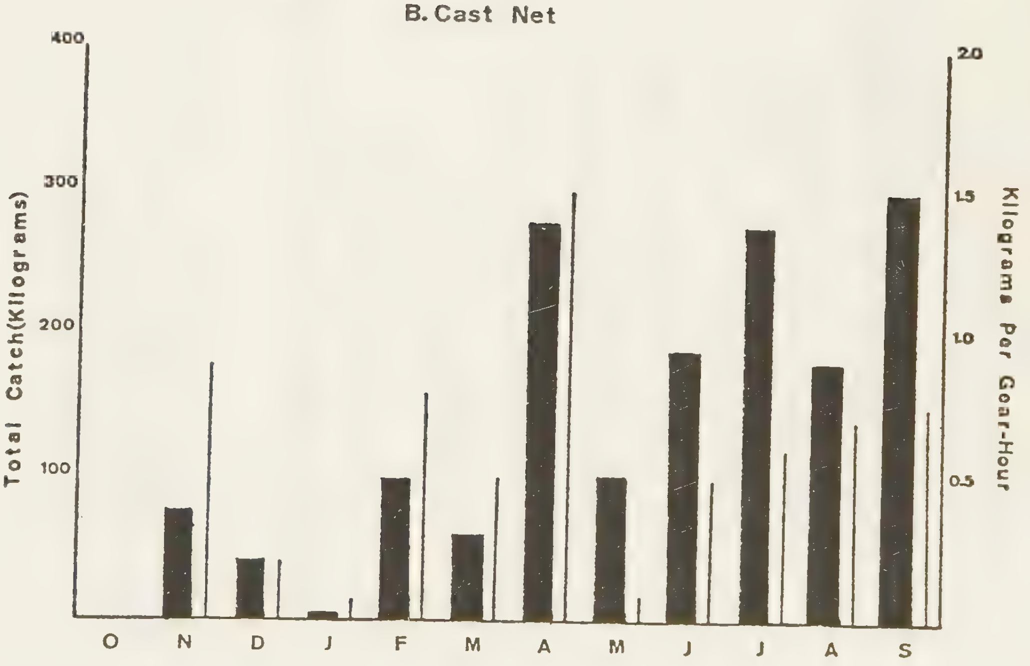
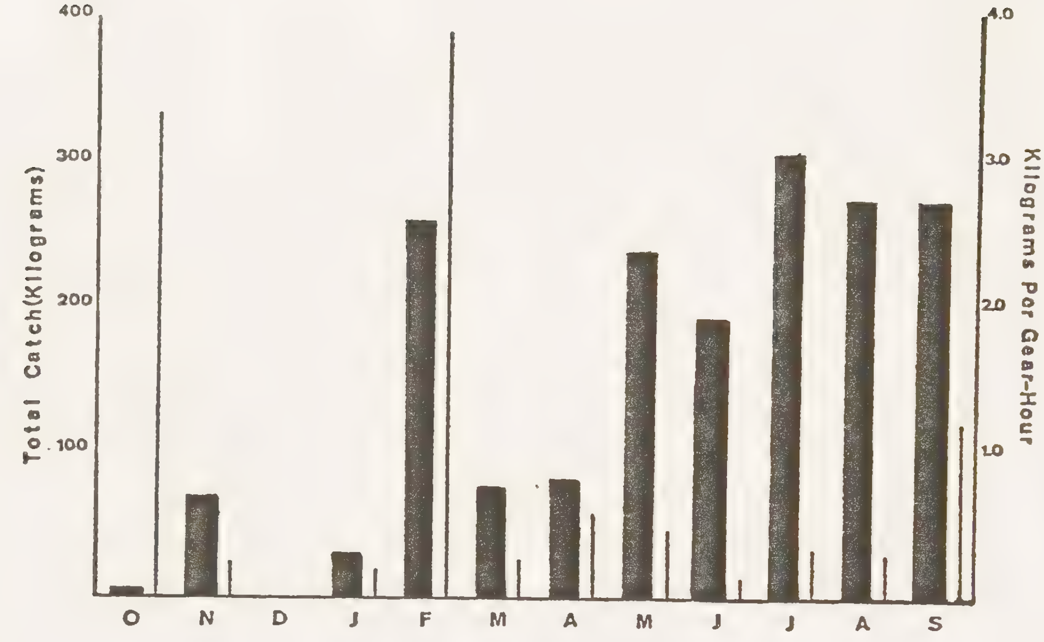


Figure 2. Monthly Total Catch (Kg) and Catch Rate (kg/Gear-Hour) for the Major Inshore Fishing Methods and for All Five Methods Combined.

C. Gill Net



D. Surround Net

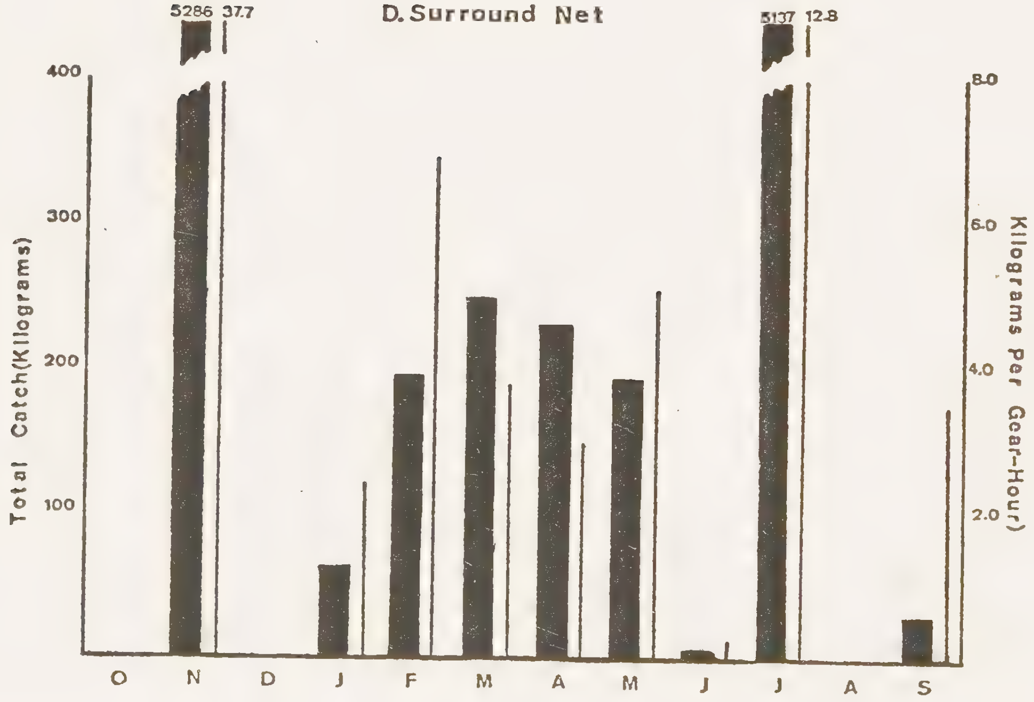
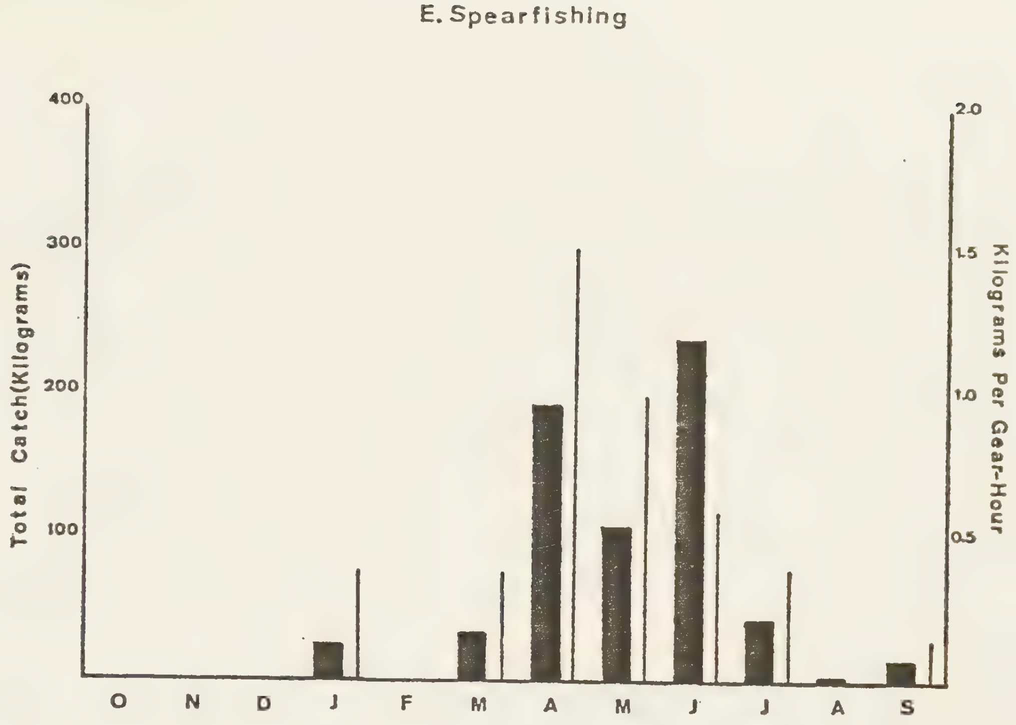
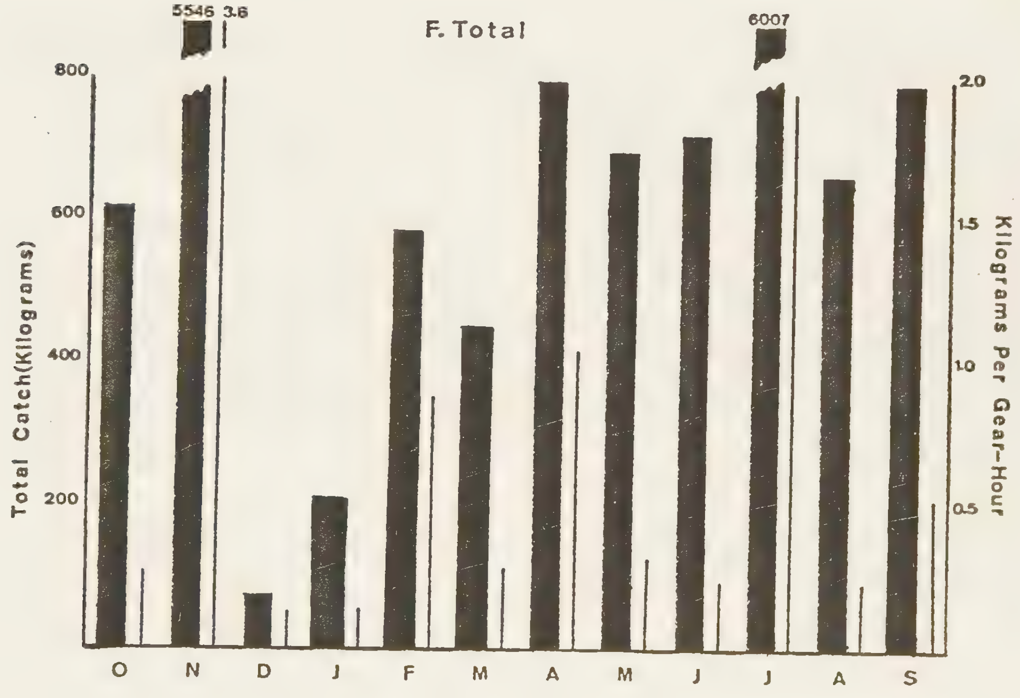


Figure 2. Continued



E. Spearfishing



F. Total

Figure 2. Continued

with the lowest effort occurring during the winter months.

Although the effort expended in surround netting was comparable to those of cast and gill netting (19.8% of the total person-hours), surround nets yielded over 66% of the total catch. Correspondingly, CPUE values (2.64 kg/P-H; 1.42 kg/G-H) were much higher for this method than those of the other methods. It should be noted that these high values reflect unusually high catches during the months of November 1979, and July 1980. The atulai (*Trachurops crumenopthalmus*) normally run from August through November and several large catches were made in November. The July high reflects large catches of tiao (*Mullodicthyes flavolineatus*) which are typically the heaviest during the summer months.

Spearfishing is the most physically demanding method of inshore fishing. Approximately 5% of the total fishing effort was devoted to spearfishing and this resulted in 3.9% of the total catch. CPUE values, however, were second only to surround netting, with approximately 0.5 kg of fish produced from each hour of fishing.

In addition, 29 persons were interviewed while taking 33 kg of octopi from the reef flats during 51 hours of fishing effort. From this information it was estimated that approximately 1,320 hours of harvesting yielded 740 kg of octopi during FY 80. This results in a CPUE value of 0.56 kg per person-hour.

Thirty persons were interviewed while harvesting shellfish, primarily the topshell *Trochus niloticus*. These people harvested 37.8 kg in approximately 50 hours, yielding total FY 80 estimates of 1,025 kg harvested by 373 persons in 1,238 hours (CPUE of 0.83 kg/P-H). Both the shellfish and octopi harvests were concentrated between the months of March and September.

RECOMMENDATIONS

The Western Pacific Fisheries Regional Management Council has proposed a region-wide program of reviewing and coding all past creel census data for incorporation into the Fisheries Information Network (FIN). Guam will participate in this program. The creel census program should be continued on a quarterly basis, and modifications resulting from the region-wide program should be incorporated.

Report prepared by Alan J. Hosmer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 3

JOB TITLE: Data Processing for Creel Census

PERIOD COVERED: October 1, 1979 to September 30, 1980

BACKGROUND

During FY 79 the offshore creel census data was coded and stored on computer diskettes. Computer programs were developed to analyze the data and generate catch, participation and catch-per-unit-effort statistics.

OBJECTIVES

Design and implement a series of computer programs, data storage, retrieval and analysis for creel census data.

RESULTS

This job was inactive during the period covered due to lack of personnel.

A position supported by the Western Pacific Fisheries Regional Management Council is proposed in FY 81. The incumbant will review and code all past creel census data for incorporation into the Western Pacific wide data base, Fisheries Information Network (FIN), in Honolulu. Guam will participate in this program, however, there may be changes in data collection, format and analysis depending upon the program requirements.

RECOMMENDATIONS

This job should remain inactive until the requirements of the FIN program are established.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 4

JOB TITLE: Compilation of a Check-List of the Fishes of Guam

PERIOD COVERED: October 1, 1979 To September 30, 1980

OBJECTIVES

To compile a checklist of all the food and game fishes found in Guam waters, listing the scientific, common and local names for each species.

RESULTS

This project was inactive during this report period. It was also inactive during FY 79.

The University of Guam is independently undertaking a similar program for compiling addenda to the checklist of Guam fish, and have identified approximately 80 additional species. This list which will be published in Micronesica, a journal of the University of Guam is included with this report. Some of the specimens of new records were supplied by the Division's personnel.

RECOMMENDATIONS

This job is being accomplished by the University of Guam and in order to avoid duplication of work it is recommended that Job No. 4, Study No. F-I be terminated with this document serving as a Final Report.

Report prepared by Robert F. Myers

List of Fishes Newly Recorded For Guam

From Myers, R.F. and J.W. Shepard, in press. "New records of fishes from Guam, with notes on the Ichthyofauna of the Southern Marianas"· Micronesica.

Squalidae
Etmopterus pusillus (Lowe)
Squalus mitsukurii Jordan & Fowler

Congridae
Gargasia sp.
Heteroconger hassi (Klausewitz & Eibl-Eibesfeldt)

Muraenidae
Echidna polyzona (Richardson)
E. unicolor Schultz
Enchelycare schismatorhynchus (Bleeker)
Gymnothorax berndti Snyder
G. goldsbaroughi Jordan & Evermann
G. nuttingi Snyder
G. sp.
Strophidon brummeri (Bleeker)
Thyrsoidea macrurus (Bleeker)
Uropterygius supraforatus (Regan)

Synaphobranchidae
Synaphobranchus sp.

Dussumieridae
Spratelloides sp.

Gobiesocidae
Aspasma sp.

Antennariidae
Antennarius sp. cf. *coccineus* (Lesson)
Antennatus tuberosus (Cuvier)
Histrio histrio (Linnaeus)

Holocentridae
Myripristis vittatus Cuvier

Syngnathidae
Cosmocampus sp.

Solenostomidae
Solenostomus armatus Weber

Scorpaenidae
Dendrochirus biocellatus (Fowler)
Scorpaena albobrunrea Günther
Scorpaenopsis cirrhosa (Thundberg)

- Cephalacanthidae
  - *Daicocus peterseni* (Nyström)

- Serranidae
  - *Anthias pleurotaenia* (Blecker)
  - *A. randalli* Lubbock & Allen
  - *A. taeniatus* Klumzinger
  - *Gracilla polleni* (Day)
  - *Liopropoma lunulatum* (Guichenet)
  - *Plectranthias fourmanoiri* Randall
  - *Plectropomus melanoleucus* (Lacépède)

- Pseudochromidae
  - *Pseudoplsiops* sp. 1.
  - *P.* sp. 2

- Apogonidae
  - *Archamia fucata* (Cantor)
  - *Cheilodipterus lineatus* (Lacepede)
  - *Siphamia versicolor* (Smith & Radcliffe)
  - *S. fistulosa* (Weber)
  - Apogonid species

- Emmelichthyidae
  - *Emmelichthys karnellai* Heemstra & Randall

- Lutjanidae
  - *Randallichtys filamentosus* Fourmanoir

- Caesionidae
  - *Pterocaesio tile* (Cuvier & Valenciennes)

- Nemipteridae
  - *Pentapodus macrurus* (Bleeker)

- Lethrinidae
  - *Gynmnocranius griseus* (Temminck & Schlegel)
  - *Lethrinus mahsena* (Forsskal)
  - *L. variegatus* Valenciennes

- Chaetodontidae
  - *Chaetodon* n.sp.
  - *Heniochus acuminatus* (Linnaeus)

- Pomacanthidae
  - *Centropyge vrolikii* (Bleeker)
  - *Genicanthus bellus* Randall
  - *G. watanabei* (Yasuda & Tominaga)

- Pomacentridae
  - *Amblyglyphidodon aureus* (Cuvier)
  - *Chromis amboineusis* (Bleeker)
  - *C. elerae*
  - *C. vanderbilti* (Fowler)

Chromis sp.1
Chromis sp.2
Chrysiptera caeruleolineatus (Allen)

Labridae
Cheilinus oxycephalus Bleeker
Cirrhilabrus n. sp.
Halichoeres hartzfeldi (Bleeker)
Hologymnosus sp.
Labropsis sp.
Pseudocheilinus octotaenia Jenkins
P. tetrataenia Schultz
Pterogogus guttatus (Fowler & Bean)
Thalassoma fuscum (Lacépède)

Blenniidae
Cirripectes quagga (Fowler & Ball)

Trichonotidae
Trichonotus sp.

Callionymidae
Callionymus xanthosemeion (Fowler)
Diplogrammus goramensis (Bleeker)
Synchiropus sp.1
Syrchiropus sp.2

Gobiidae
Amblygobius guttatus (Fowler)
A. steinitzi (Klausewitz)
Amblyeleotris sp.
Amblygobius decussatus (Bleeker)
Cottogobius sp.1
Cottogobius sp.2
Ctenogobiops pomastictus Lubbock & Polunin
C. tangaroai Lubbock & Polunin
Fusigobius sp.
Istigobius spence (Smith)
Lotilia graciliosa Klausewitz
Ptereleotris evides (Jordan & Hubbs)
Redigobius sp.
Trimma sp.1
Trimma sp.2
Valenciennea puellaris (Tomiyama)

Kraemeridae
Kraemeria samoensis Steindachner

Nomeidae
Psenes cyanophrys Cuvier & Valenciennes

Balistidae
Canthidermis maculatus (Procé)
Xanthichthys auromarginatus (Bennett)
X. caeruleolineatus Randall, Matsuura & Zawa

Monacanthidae
Amanses scopas (Cuvier)

Tetraodontidae
Canthigaster coronata (Vaillant & Sauvage)
C. epilampra (Jenkins)
C. leoparda Lubbock & Allen

In addition, the following species from Rota, Tinian and Saipan have been recorded for the first time from the Mariana Islands:

Rhynchobatidae
Rhynchobatus djeddensis (Forsskol)

Muraenidae
Gymnothorax marshallensis (Schultz)
G. pindae Smith

Scorpaenidae
Scorpaenodes brocki (Schultz)

Serranidae
Liopropoma pallidum (Fowler)

Pomacanthidae
Centropyge nigriocellus Woods & Schultz

Labridae
Novaculichthys macrolepidotus (Bleeker)

Uranoscopidae
Uranoscopus kaianus Günther (previously reported by Grigg & Eldredge, 1975)

Gobiidae
Gobiodon rivulatus Rüppell
Hazeus unisquamis Gosline

Microdesmidae
Gunnellichthys monostigma Smith

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 5

JOB TITLE: Reef Fish Population Investigations Through the Use of Permanent Transects

PERIOD COVERED: October 1, 1979 To September 30, 1980

SUMMARY

A total of 382 transect counts were made from September 1979 through September 1980. The data for 350 of these counts were recorded on a submersible micro-cassette tape deck in the field. The remaining data were recorded on underwater paper. Analysis of the data has begun although the study is still in progress. A complete presentation of the results will be included in our annual report for FY 81.

BACKGROUND

During the spring of 1979 permanent underwater 50 m transects were established at two locations on Guam, Asan Pt. and Ipao Pt. (Figure 1), for the purpose of monitoring reef fish populations. The conspicuous fishes on these transects were observed from June through August 1979.

OBJECTIVES

The major objective of this study is to examine the variability associated with reef fish populations on coral reefs. Hopefully, this study will help identify possible sources of variability and quantify, in at least relative terms, the extent to which these variables may affect the species composition, abundance, and/or distribution of certain reef fishes within localized areas. The variables most closely examined in this study include depth, location (of study area), substrate and time.

PROCEDURE

At each study site, duplicate 50 m transects were placed end to end along depth contours of 15, 30, 60 and 100 feet (14.6, 9.1, 18.3 and 30.5 meters, respectively). A transect consists of six unconnected rebar stakes, each one approximately 15 inches (38 cm) in length, embedded into reef rock at 10 m intervals. To aid in their location on subsequent field days, each stake was flagged with a small piece of plastic surveyor's marking tape.

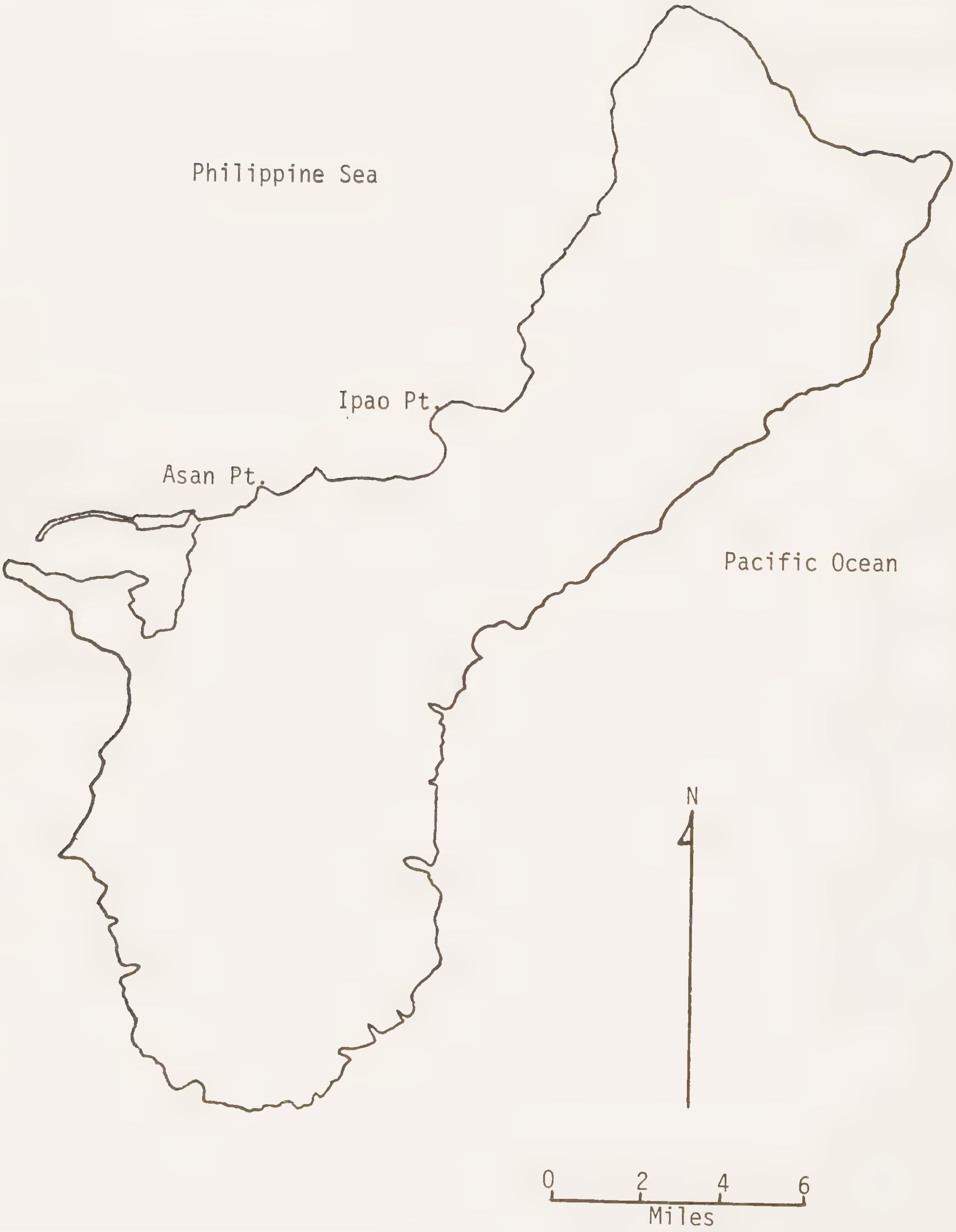

Philippine Sea
Ipao Pt.
Asan Pt.
Pacific Ocean
N
0
2
4
6
Miles

Figure 1. Map of Guam showing the locations of the study sites.

Since September of 1979 the fishes on these transects have been censused monthly through the use of SCUBA. Counts of individuals have been made of fish species observed within a vertical 2 m^2 area centered and running from stake to stake on each transect. All of the counts were performed between 1000 and 1400 hours.

The underwater data were recorded on a waterproofed micro-cassette tape deck carried by the biologist. Both the plexiglas housing for the tape deck and the special SCUBA regulator mouthpiece containing the remote microphone were manufactured under the name of Wet Tape, by Sound-Wave Systems, Inc.

As the fish count data are being processed, we expect to shift the field emphasis to the collection of substrate relief and porosity data. Each 10 m section of transect may be ranked in terms of its relief and/or porosity by fitting each to matrices based on field measurements of vertical relief and subjective evaluations of porosity (Fig. 2). The fish faunas of sections with similar substrate relief and porosity estimates may then be compared.

The variable of time will be sub-divided into the following: seasonal (rainy/dry), monthly and "instantaneous". Seasonal variability will be estimated by comparing counts made during rainy season months with those made during dry season months. Monthly variability will be estimated by comparing counts made from month to month. An estimate of "instantaneous" variability (and "diver effect") will be derived from the replicate transect counts made on the same dive. If possible, variability in the fish counts due to weather differences within a single month will be examined. This can be done only if transect sections at both study locations are found to be comparable in habitat and fish population characteristics.

RESULTS

The use of the Wet Tape unit proved to be a very effective way of collecting reef fish data for obvious reasons. The observer rarely had to take his eyes away from the transect, and could speak his observations faster then he could write them down. The major limitation of this method was the maximum length of the available micro-cassette tapes, which were either 15 or 20 minutes per side. Since the manually controlled off-on switch allowed the diver to run the tape deck only when needed, the 20 minute tapes provided more than enough time to record fish counts on two 50 m transects twice during the same dive. The 15 minute tapes were found to be adequate although marginal at times.

Normally, the transects at two depths were censused on any one field day. On a single dive, data from each 50 m transect at a particular depth were recorded twice (down & back). There were exceptions, however, due to the occasional failure of the Wet Tape System, making it necessary to record data by hand. For example, because of the relatively short no decompression time allowed for a dive to 100 feet (25 min), the transects at this depth were censused only once (one direction only) on days when data had to be written down.

Unfortunately, corrosion claimed the remote off-on switch on the Wet Tape housing, rendering the unit inoperable before the end of the study. Since it was not possible to replace the unit in time, data for the last three months of the study were recorded on underwater paper. However, of the 382 transect counts that were made from September 79 through September 80 a total of 350 counts were recorded on tape. The remaining counts were recorded on paper.

VERTICAL RELIEF

	NONE	LOW	MODERATE	HIGH	EXTREME
NONE					
LOW					
MODERATE					
HIGH					
EXTREME					

Figure 2. Substrate ranking matrix based on field measurements of vertical relief, and subjective porosity estimates based on the numbers and sizes of holes. Each 10-meter section of transect may be assigned to an appropriate box within the matrix.

Wind, rainfall and sea swell data have been provided by the weather office at the U.S. Navy Air Station, Guam, since July of 1979. Their cooperation and assistance in this project is greatly appreciated. Since the weather conditions preceeding a census day may significantly influence the results of that day's fish counts, particular importance has been placed on weather analyses for the three days prior to a particular census day.

RECOMMENDATION

Fish counts should be made on the transects for two more months. This will provide a data base spanning 15 months and should ensure that a complete seasonal cycle for the fish populations will be represented. Substrate relief and porosity data should be collected in order to characterize the transects for analysis purposes.

Report prepared by Michael E. Molina

Fisheries biologist conducting underwater transects.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-I
JOB NO.: 6

JOB TITLE: Preparation of the Creel Census and Fish Population Studies Annual Report

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

The objective of this Job is to assemble and analyze the data collected under Jobs 1 to 5 of Study No. F-I, and to present a summary and analysis of the findings in a form suitable for release to the general public.

RESULTS

This Job is completed with the submission of FY 80 Job Progress Reports

RECOMMENDATIONS

This Job should be included within the budget for each specific Job and not carried as a separate Job Number.

It is recommended that Job No. 6 of Study No. F-I be terminated with this document serving as a Final Report.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam PROJECT NO.: FW-2R-17

PROJECT TITLE: Guam Fish and Wildlife Investigations

STUDY TITLE: Limnological Investigations (F-II)

PERIOD COVERED: October 1, 1979 to September 30, 1980

This study is comprised of three jobs which will be reported under the job title. These jobs involve limnological surveys in major streams and rivers on Guam and studies in the Masso River watershed. The third job is report preparation of the first two.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 1

JOB TITLE: Limnological Surveys of the Major Streams and Rivers

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Preliminary air and water temperature data and water samples were collected from two experimental watersheds in southern Guam. Floral and faunal collections were also made. Data from four vegetational transects were collected. Nitrate, nitrite, ortho and total phosphates, pH, conductivities, turbidity and hardness parameters were determined from water samples.

BACKGROUND

Very few studies have been conducted on the freshwater rivers and streams of Guam. An ecological survey of the Agfayan River mouth was conducted by Aquatic & Wildlife Resources (AWR) from July 1, 1968 to June 30, 1972. Salinity, pH and temperature data, as well as lists of organisms collected or observed in the river mouth were included in the Annual DAWR Progress Reports. This study dealt primarily with the estuarine system.

In a preliminary study to rehabilitate the Masso River Reservoir into a public fishing and recreation area (July 1, 1971 to June 30, 1972), small gobies, eels and shrimp are mentioned as the principal inhabitants of the reservoir and feeder streams.

A limnological survey of the major streams and rivers of Guam was initiated during the period of June 30, 1974 to July 1, 1975. The Geus River, located in the southern tip of the island, and the Lonfit River in the central highlands, were investigated. Six species of fish, three species of shrimp and an aquatic gastropod were observed or collected from the Geus River. Five of the six species of fish, and two of the three species of shrimp present in the Geus River were also collected or observed from the Lonfit River. Two species of aquatic gastropods were taken in the Lonfit River.

The Geus River was found to be unsuitable for stocking gamefish or development as a fishing area. The Lonfit River was judged suitable for a stocking and development program, however, this program was deferred because of limited access to the river. The University of Guam Marine Laboratory Technical Report No. 16 (1974) discusses the physical, limnological and biological components of the Geus River drainage basin. Organisms were collected and catalogued from established stations on the Ylig, Geus and Umatac Rivers during FY 77. Preliminary stomach content analyses of three fish species, Microsicydium elegans, Eleotris fusca and Chonophorus guamensis were performed during the report period. The collection of air and water temperatures and flow readings was initiated during this period. Breeding and reproduction observations were made of one species of fish.

Water temperatures, flow rates and biological data were collected monthly from permanent monitoring stations on the Geus and Umatac Rivers during FY 1978. The Ylig River was monitored at 3 stations during November 1977 and March 1978.

Seven sampling stations were established on the Ugum and Bubulao River system. The names of the organisms present were listed in our Job Progress Report for FY 79. In this report observations on the spawning of Microsicydium elegans are presented, and a life cycle outline is proposed. An extensive list of the algae collected from the various rivers is included.

Preliminary biological surveys were conducted on the Inarajan River, Agana Swamp, Naval Communication Station (NCS) pool and two small watersheds in the Fena system during FY 79. Water temperature and flow rate data were collected from the Geus River.

OBJECTIVES

I. To identify aquatic organisms present in the streams and rivers, and to determine the distributional patterns of these organisms.

II. To publish working keys and descriptions of the freshwater fishes of Guam, and to gather biological data on the dominant species.

III. To survey the streams and rivers for possible future development for recreational use.

IV. To gather limnological data from small watersheds for possible future development and management purposes.

PROCEDURES

I. Terrestrial and aquatic organisms were collected, identified and catalogued, from two watersheds in southern Guam.

II. Water samples, and maximum-minimum air and water temperatures were collected every two weeks from permanent sampling stations established in the watersheds.

III. Nitrate, nitrite, ortho and total phosphate, hardness, pH, conductivity, turbidity and hardness were determined from water samples. Standard methods were used to analyse the water samples.

IV. All vegetation from a section of one watershed in southern Guam was cut down by hand and left in place to determine the effects of land clearing on the limnology of a watershed.

FINDINGS

Two primary seasons exist on Guam; wet (mid-July to mid-November) and dry (January - April). Two secondary, transition seasons occur from May to mid-July and mid-November through December. Precipitation varies in the transitional seasons. Relative humidity ranges from 65-75% during the day to 85-100% at night (U.S. Dept. of Commerce, 1963).

Annual average rainfall is 225 cm; 60% of which falls during the wet season and 15% during the dry season. Heaviest rainful occurs over the southern mountains, east of the Naval Station in the area of Fena watershed (Jordan, 1955). Rainfalls greater than 330 cm have been recorded in these areas. Air temperatures average 27.2°C, with a mean range of 26.2 to 28.0°C. The highest and lowest temperatures recorded from Guam are 35.0°C and 13.3°C, respectively.

The geology of the study site is classified as the Bolanos pyroclastic member, consisting of massive reworked tuff breccia and volcanic conglomerate, containing fragments of the Maemong limestone member. The upper part consists of tuffaceous sandstone and shale imbedded with minor amounts of conglomerate. This member interfingers with the Dandan flow member on the eastern slope of Mount Almagosa (Tracey et al 1964). Evidence of the Dandan flow overlying the Bolanos member site was observed in the study.

Stream beds of the study site possess a steep gradient. Black volcanic outcrops are present in riffle areas. The outcrops have little or no alluvium present on them. Pool areas are small ($<1m^2$) and have substrates of sand and gravel. Station 4 has fine silt covering the pool area. Stream width is generally less than 1m and the depth less than 0.5m.

The vegetation of these watersheds is classified as Ravine Forest (Fosberg, 1960). The sites were chosen based on characteristics discussed in Fisher and Likens (1973) and Rothacher et al. (1967). Small adjacent experimental watersheds are used in research because they generally possess similar vegetation, geology, and climate. Variations between these sites in drainage basin size and elevation are negligible. These sites were chosen also because they are accessible, they lie on restricted U.S. Naval property and the small rivers flow perenially.

Data from four transects were collected from the experimental watershed and are presented in Table 1. The point quarter method for vegetation analysis was used to quantify the dominant vegetation. Only trees greater than 2m in height were measured. *Pandanus tectonius* was the dominant tree specie of the experimental watershed. *Areca cathecu*, the local betel nut tree, was the second most dominant tree in the site. *Areca* has an importance value slightly greater than *Pandanus dubius* another abundant tree. All trees recorded along the transects are considered ravine forest species. Water chemistry and temperature data will not be included in this report because these data constitute a major portion of an uncompleted University of Guam Masters' thesis.

Table 1. Results of Vegetation Analysis From the Ugum River Experimental Watershed.

Species	Relative Density	Relative Dominance	Relative Frequency	I.V.	Rank
Pandanus tectorius Parkinson	41.25	53.43	32.65	127.33	1
Areca cathecu L.	17.50	7.43	18.37	43.30	2
Pandanus dubius Sprengel	13.75	12.27	8.16	34.18	3
Cycas circinalis L.	7.50	6.13	12.24	25.87	4
Ficus tinctoria G. Forster	7.50	4.42	8.16	20.08	5
Morinda citrafolia L.	6.25	2.99	10.20	19.44	6
Mangifera sp.	1.25	9.28	2.04	12.57	7
Hibiscus tiliacius L.	2.50	0.60	4.08	7.18	8
Glochidion marianum Mueller-Argouiensis	1.25	2.08	2.04	5.37	9
Mediniua rosea Gaudichavio	1.25	0.94	2.04	4.23	10

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RECOMMENDATIONS

I. The study should be continued with more emphasis placed on studying the biology of the local species.

II. The larger, deeper rivers on Guam should be investigated with regard to future stocking programs.

III. Watershed studies should be continued, especially studies on the effects of fires and bulldozing.

Report prepared by Clifford P. Neubauer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 2

JOB TITLE: Masso River Watershed Studies

PERIOD COVERED: October 1, 1979 to September 30, 1980

BACKGROUND

During FY 79, the fauna of Masso Reservoir and its feeder streams was sampled. Aquatic organisms collected include two eels (*Anguilla mormorata* and *A. bicolor*), three gobies (*Chonophorous guamensis*, *Microsicydium elegans*, and *Sicyopterus macrostetholepis*) and eleotrid (*Eleotris fusca*), several shrimps (*Atya* sp., *Caridina* sp., and *Macrobrachium lar*), tadpoles of *Bufo marinus*, and a variety of insect larvae and small invertebrates.

OBJECTIVES

To formulate fisheries and recreational management plans for present and future reservoirs.

RESULTS

This job was inactive during the period covered due to lack of personnel and equipment failures.

RECOMMENDATION

As Masso Reservoir is currently being stocked and will soon be opened for public fishing, this job should be continued.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 3

JOB TITLE: Preparation of the Limnological Investigations Annual Report

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To assemble and analyze the data collected under Jobs 1 and 2 of Study F-II, and to present a summary and analysis of the findings in a form suitable for release to the general public.

RESULTS

This Job is completed with the submission of FY 80 Job Progress Reports.

RECOMMENDATIONS

This Job should be included within the budget for each specific Job Number. It is recommended that Job No. 3 of Study No. F-II be terminated with this document serving as a Final Report.

PTDF
Seamount Groundfish Development Project - Guam
May, 1980 - January 1981
FV TYPHOON

Prepared by

Alan Hosmer
Harry Kami
Aquatic And Wildlife Resources, Guam

MARCH 1981

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PTDF - SEAMOUNT GROUNDFISH DEVELOPMENT PROJECT
FV TYPHOON
GUAM 1980

INTRODUCTION

Guam is a high net importer of fish and fish products from a variety of foreign sources. In an attempt to reduce this market inbalance, the Pacific Tuna Development Foundation (PTDF) chartered the FV Typhoon (Appendix A) for 300 days to conduct exploratory bottom fishing surveys within the FCZ's of Guam and the Northern Mariana Islands (NMI). This report presents the results of surveys conducted from May 20, 1980 to January 6, 1981, on the seamounts of the South Honshu Range and throughout the entire Mariana's chain. The ultimate goal of this project was to establish a fishery for alfonsin (*Beryx splendons*) and other demersal species on the deep banks and seamounts.

Project management and scientific observers were provided by Aquatic and Wildlife Resources, Guam. National Marine Fisheries Service, Honolulu (NMFS) provided gear and laboratory services.

BACKGROUND

Commercial stocks of alfonsin and pelagic armorhead (*Pentaceros richardsoni*) were discovered on the seamounts northwest of the Hawaiian Islands in 1967. In subsequent years a valuable trawl and longline fishery, dominated by the Japanese and Russians, developed on these seamounts. Based upon limited data, the fisheries appear to have been most productive in the early years (1969-71), with annual decreases in catch occurring concurrently with increased effort. No U.S. commerical fishing vessels have fished the north central Pacific seamounts, and thus first hand knowledge of this fishery is limited.

No records were obtained which document the occurrance of alfonsin or armorhead within the study area of this project. An inquiry was made to the Fisheries Agency of Japan. Their alfonsin fishing grounds include the Izu islands, Milwaukee seamounts and banks near Japan; all located north of 30^{o} latitude and outside the present survey area.

AREAS OF OPERATION

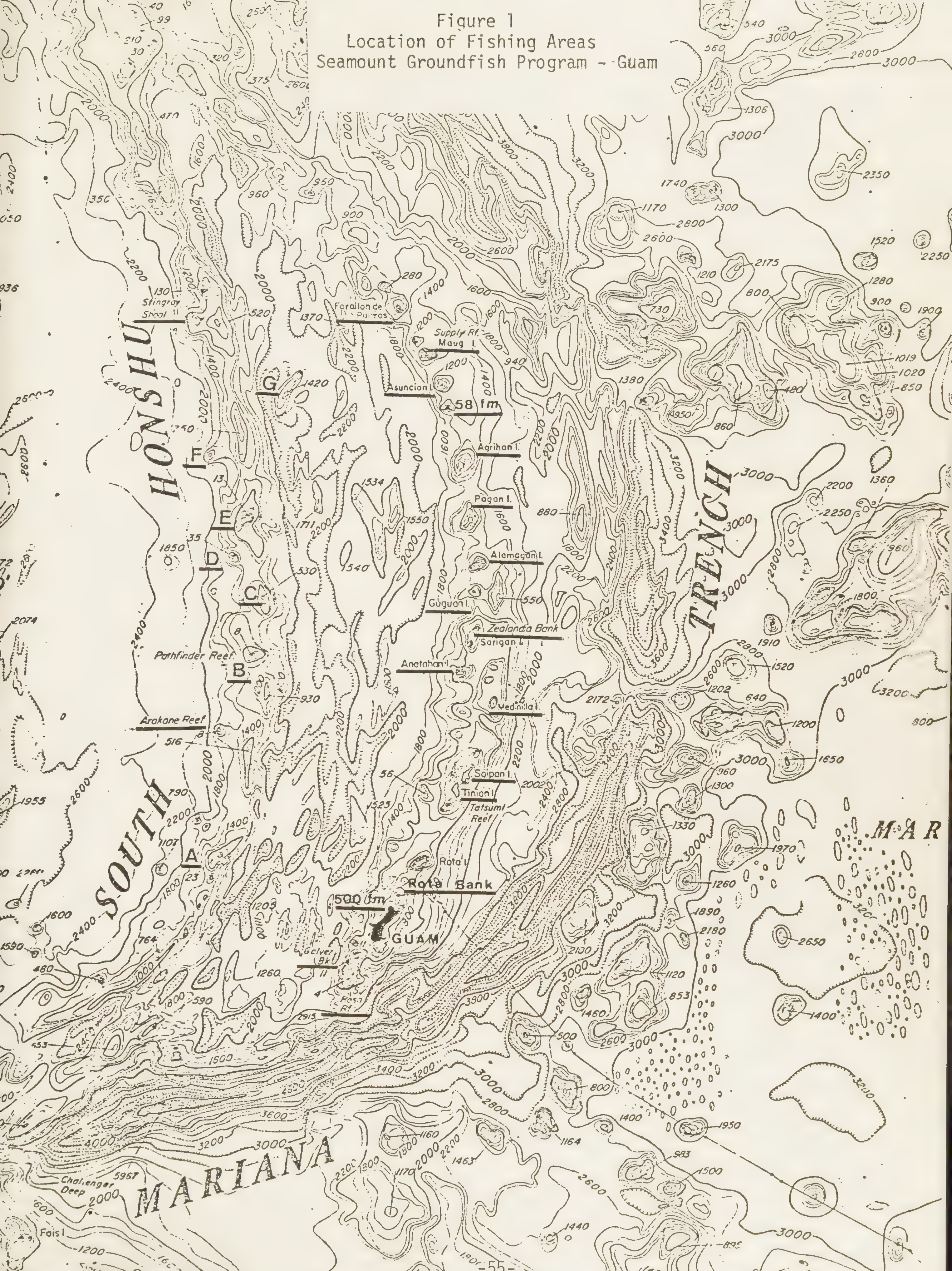
Figure 1 presents the seamounts, reefs, and islands fished during the groundfish survey. During the early phases, efforts were concentrated on the South Honshu Seamount Range. Typically, these seamounts are singular, steep-sided pinnacles, the tops having diameters ranging from 2.0 miles to less than 0.5 miles. Minimum depths of the seamounts ranged from 2 fm to 286 fm. The near vertical gradients most often extend well below fishable depths. The nearshore waters (20 to 200 fm) surrounding the Mariana Islands were fished from Guam to the northern most island of Farallon de Pajaros. Banks within the island chain (Santa Rosa, Galvez, Zealandia, "58 fm") were also surveyed. All fishing activities were conducted between the latitudes of 12^{o}50'N and 20^{o}50'N.

FISHING OPERATIONS

Eighteen fishing cruises, totaling 172 days of operation were conducted. Cruises ranged in length from 3 to 18 days, depending upon the location of the fishing ground. Fifty-nine days were spent in the port of Guam and devoted to the preparation of fishing gear, reprovisioning the vessel, off-loading catches and changing observers.

Incidental trolling, with handlines, was conducted en route to and from the fishing areas. These fish were marketed with the bottomfish, as well as

Figure 1
Location of Fishing Areas
Seamount Groundfish Program - Guam



SOUTH HONSHU
MARIANA TRENCH
MAR
Stingray Shoal
Farallon de Pajaros
Supply Rf.
Maug I.
Asuncion I.
58 fm
Agrihan I.
Pagan I.
Alamagan I.
Guguan I.
Zealandia Bank
Sarigan I.
Anatahan I.
Medinilla I.
Saipan I.
Tinian I.
Tatsumi Reef
Rota I.
Rota Bank
500 fm
GUAM
Galvez Bk
Rota Rf.
Pathfinder Reef
Arakane Reef
Challenger Deep
Fais I.
A
B
C
D
E
F
G

used for bait. Upon locating a seamount, fathometer tracings were conducted to ascertain the dimensions of the seamount and search for schools of fish.

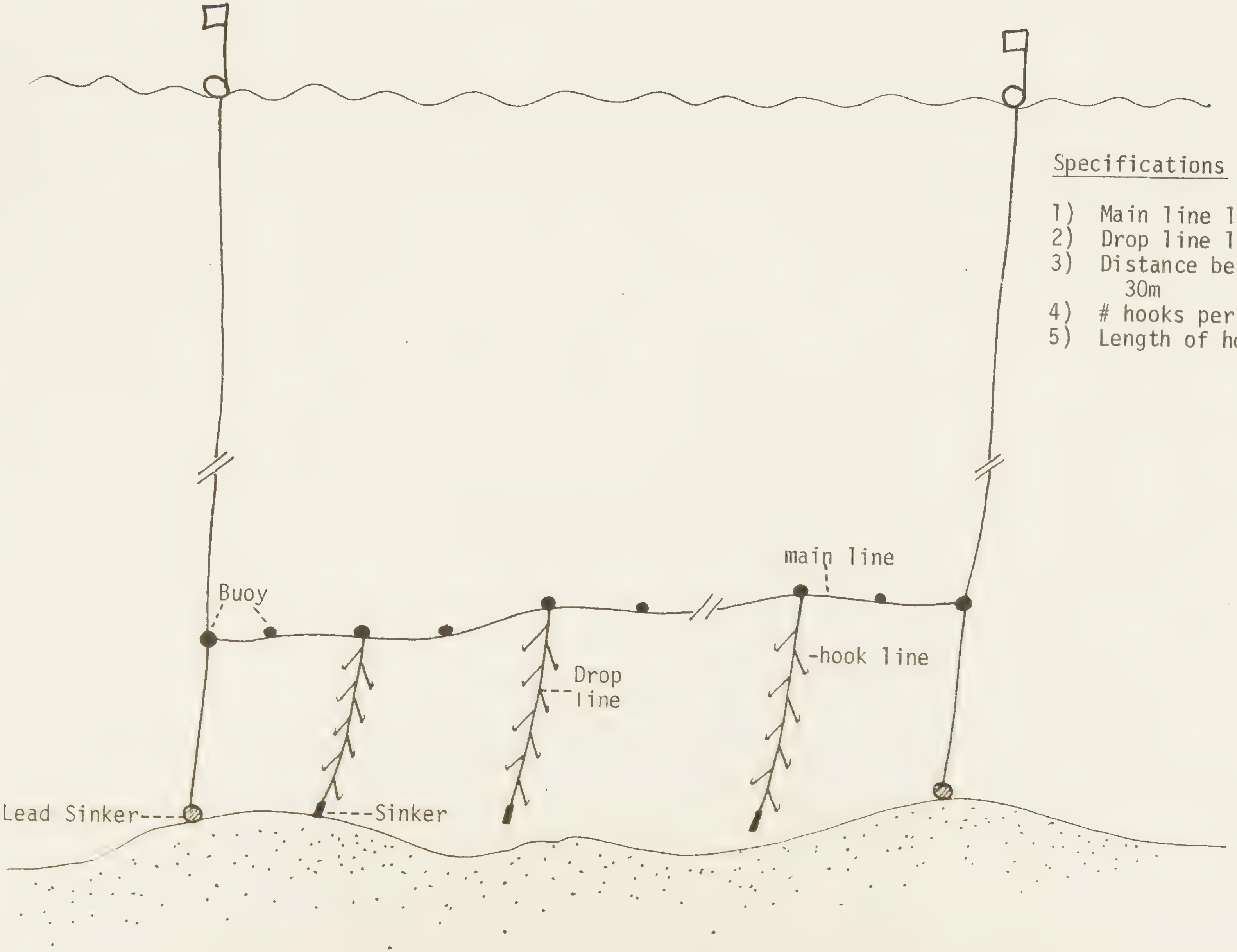
Several types of bottomfishing gear were employed during this project. Difficulties were encountered in fishing the steep-sided seamounts, and vertical handlines mounted on hydraulic reels proved the most effective gear. As bottom longlines are used successfully in the Hawaiian alfonsin fishery, our initial efforts emphasized this gear. A "Japanese" longline was attempted first. This gear consisted of a mainline, with five, 10 meter droplines spaced at 30 meter intervals (Fig. 2). Each dropline had 20 hooks, for a total of 100 hooks. Problems were encountered in fishing this gear. The seamounts provided no level areas at the top of the mounts, and thus attempts were made to fish the sloping sides. This frequently resulted in tangled or lost sets.

Alternatively, an "Alaskan" style longline was fabricated (Fig. 3). This longline eliminates the droplines and it was hoped that snagging and tangling would be reduced. The line consisted of a mainline with approximately 300 hooklines spaced at 1.2 meter intervals. Neither style of longline gear was successful.

Vertical setlines (Fig. 4) were also fished. These lines consisted of a single, vertical mainline with approximately 40 hooks. This gear could be set in areas too small for the longlines or directly on fish metered with the fathometer.

Vertical handlines, mounted on hydraulic reels, were the primary method of fishing. Two or three lines were fished at a time, and each line had two to five hooks. Lines were weighted with approximately 3 kg sinkers. In an

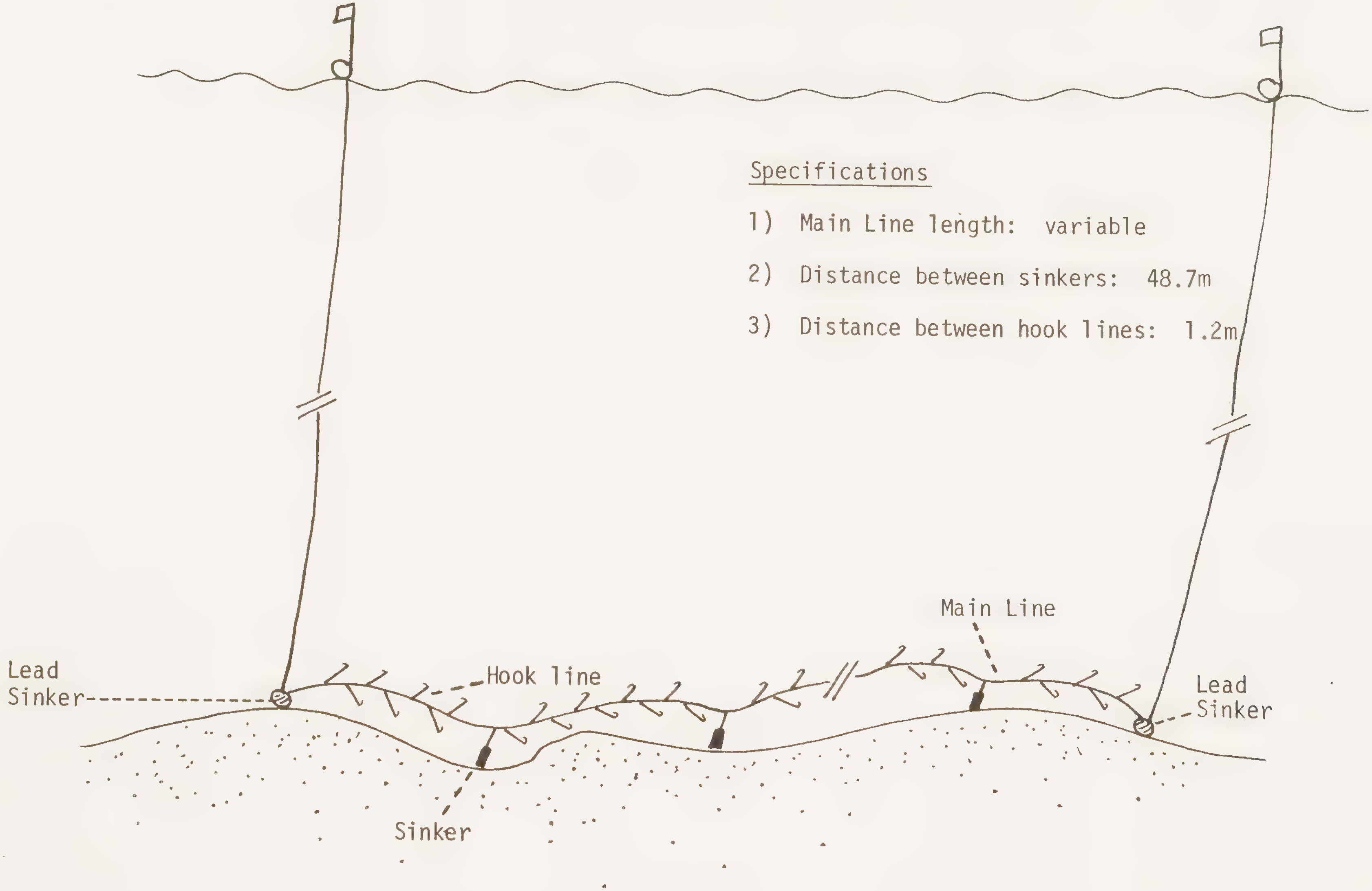
Figure 2
Japanese Bottom Longline-
Seamount Groundfish Program-Guam


Buoy
main line
-hook line
Drop line
Lead Sinker
Sinker

Specifications

1) Main line length: variable
2) Drop line length: 10m
3) Distance between drop lines: 30m
4) # hooks per drop line: 20
5) Length of hook line: 0.5m

Figure 3
"Alaskan" Bottom Longline
Seamount Groundfish Program-Guam


Lead Sinker
Hook line
Main Line
Sinker
Lead Sinker

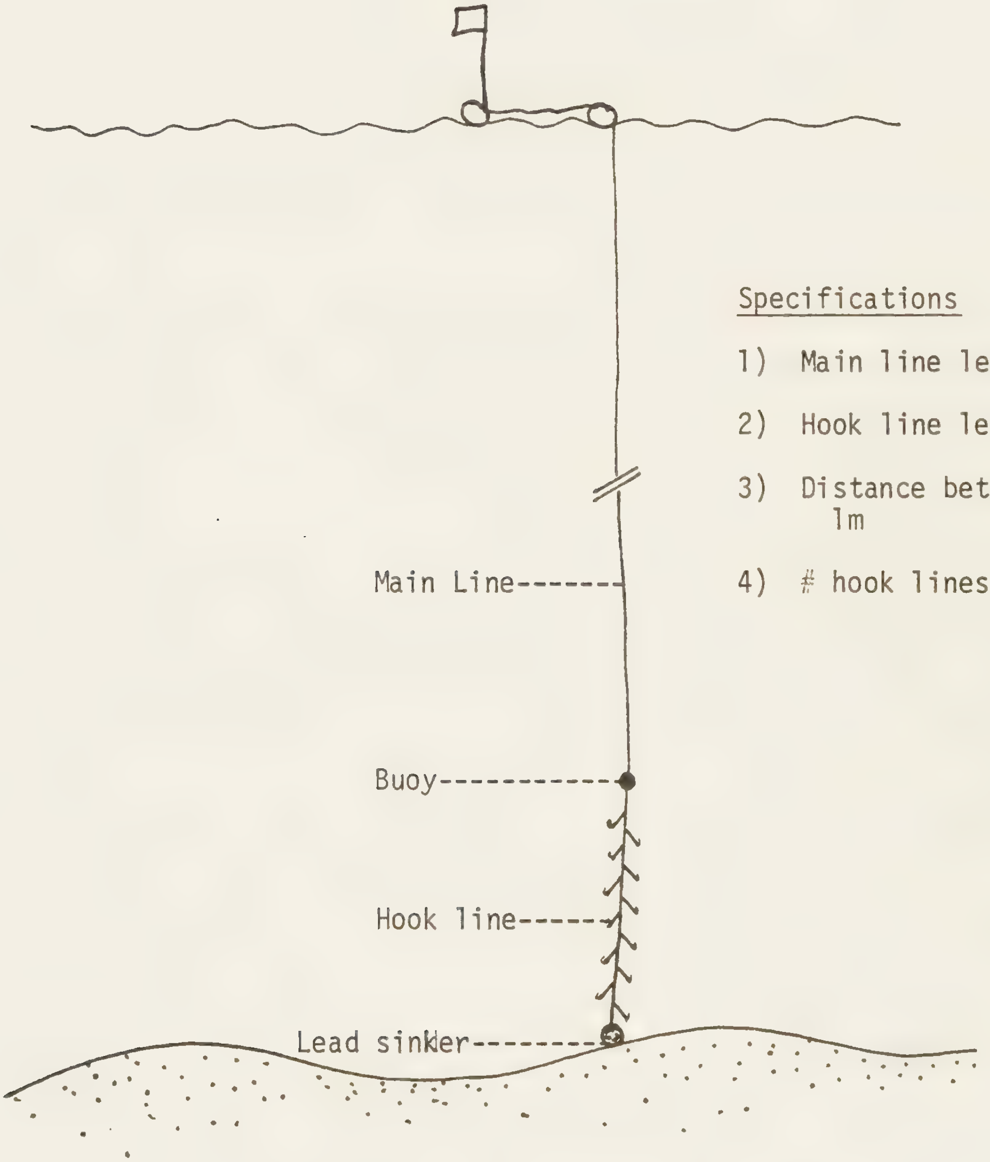
Specifications

1) Main Line length: variable

2) Distance between sinkers: 48.7m

3) Distance between hook lines: 1.2m

Figure 4
Vertical Setline
Seamount Groundfish Program-Guam


Main Line
Buoy
Hook line
Lead sinker

Specifications

1) Main line length-variable

2) Hook line length: 15cm

3) Distance between hook lines: 1m

4) # hook lines: 40

attempt to fish greater depths, the dacron line was replaced with stainless steel wire on one reel. This wire reduced the drag and could be fished down to 350 fm, however, it was difficult to handle, costly, and problems occured with the wire kinking. Handlines were fished while both anchored and drifting. Drifts usually began over the shallow portion of the reef or seamount, and ended when depths became unfishable . Handlines were fished from 20 to 350 fm, however over 75% of the gear-hours were between 50 and 175 fm. Approximately 85% of the fishing occured between 0600 and 1900 hrs.

A 1500 watt submersible light was used for night-light observations and akule (Trachurops crumenopthalmus) handline fishing. Fish, lobster and shrimp traps were used occassionally, however difficulties were encountered in retrieving the gear and several traps were lost.

Pieces of fresh skipjack tuna (Katsuwonus pelamis) and frozen squid were used as bait for the handlines, longlines and setlines. Lobster and shrimp traps were baited with skipjack tuna only, and fish traps were unbaited.

FISHING RESULTS

Gear-hours for all bottomfishing methods totaled 1233.6 hours. All but 174.5 hours were devoted to vertical handlining. The total bottomfish catch was 5018 kg, (5.5 tons) for a combined method, catch-per-unit-effort (CPUE) of 4.1 kg/gear-hour.

Table 1 lists the bottomfish species taken and provides catch composition data for vertical handlines. The jacks Caranx lugubris (ulua) and Seriola purpurascens (kahala) collectively totaled 1540.1 kg or 31% of the catch. Caranx lugubris was a ubiquitous species near the islands and on the seamounts. Numerically, Seriola purpurascens accounted for less than 5% of the catch and were most common on the shallower reefs and seamounts.

Table 1. Vertical Handline, Catch Composition Data, Seamount Groundfish Development Project - Guam

Family/Species	Total Number	Percent of Total Catch By Number	Total Weight (Kg)	Percent of Total Catch By Weight	Mean Weight (Kg)
Squalidae (spiny dogfish):					
Etmopterus villosus	6	<.5%	8.6	<.5	1.43
Congridae (conger eels):					
Congridae sp.	2	<.5%	7	<.5	3.50
Muraenidae (moray eels):					
Gymnothorax richardsoni	1	<.5%	1.5	<.5	1.5
Bramidae (pomfrets):					
Eumegistus illustris	1	<.5%	6.5	<.5	6.5
Carangidae (jacks)					
Carangoides ferdau	6	<.5%	8.5	<.5	1.42
Caranx helvolus	2	<.5%	1.6	<.5	0.80
C. ignoblis	52	2%	41.2	0.8	0.79
C. lugubris	305	12%	900.9	18.1	2.95
C. melampygus	6	<.5%	10.5	<.5	1.75
Seriola pupurascens	85	3.4	639.2	12.9	7.52
Trachurops crumenopthalmus	188	7.5%	37.0	0.7	0.20
Gempylidae (snake mackerals):					
Promethichtys prometheus	14	0.6%	13.4	<.5	0.96
Ruvettus pretiosus	1	<.5%	12.8	<.5	12.8
Lutjanidae (snappers):					
Aphareus furcatus	1	<.5%	0.5	<.5	0.5
A. rutilans	18	0.7%	85.6	1.7	4.76
Aprion virescens	2	<.5%	12.3	<.5	6.15
Etelis carbunculus	62	2.5%	417.3	8.4	6.73
E. marshi	287	11.5%	282.1	5.7	0.98
E. nudimaxillaris	1	<.5%	3.2	<.5	3.2
Gymnocranius japonicus	7	<.5	19.5	<.5	2.79
Lethrinus miniatus	1	<.5	0.5	<.5	0.5
L. variegatus	111	4.4%	132.6	2.7	1.19
Lethrinus sp.	1	<.5	1.9	<.5	1.9
Lutjanus bohar	23	0.9%	73.5	1.5	3.20
L. kasmira	16	0.6%	5.9	<.5	0.37

Table 1. Continued

Family/Species	Total Number	Percent of Total Catch By Number	Total Weight (Kg)	Percent of Total Catch By Weight	Mean Weight (Kg)
Pristipomoides auricilla	185	7.4%	196.2	3.9	1.06
P. filamentosus	133	5.3%	204.3	4.1	1.54
P. flavipinnus	53	2.1%	123.1	2.5	2.32
P. sieboldi	3	<.5	1.4	<.5	0.47
Rooseveltia brighami	809	32.3%	1071.3	21.5	1.32
Tropidinus amaenus	9	<.5	2.8	<.5	0.31
Mullidae (goatfish):					
Parupeneus chryserydros	1	<.5	0.4	<.5	0.4
Polymixidae (beardfish):					
Polymixia japonica	9	<.5	4.2	<.5	0.47
Scorpaenidae (Scorpianfish):					
Pontinus macrocephalus	1	<.5	0.4	<.5	0.4
Serranidae (seabass):					
Cephalopholis aurantius	4	<.5	10.2	<.5	2.55
C. igarasienis	2	<.5	2.4	<.5	1.2
C. obtusarus	10	<.5	8.8	<.5	0.88
C. pachycentron	6	<.5	117.4	2.4	19.57
Epinephalus albopunctulatus	19	.7%	24.1	0.5	1.27
E. cometae	9	<.5	49.1	1.0	5.46
E. faciatus	5	<.5	2.5	<.5	0.5
E. microdon	7	<.5	20.3	<.5	2.90
E. tauvina	20	0.8%	269.2	5.4	13.46
Epinephalus sp.	2	<.5	49.7	1.0	24.85
Sebasticus sp.	1	<.5	0.7	<.5	0.7
Serranidae sp.	3	<.5	66.4	1.3	22.13
Variloa louti	5	<.5	8.2	<.5	1.64
Scombridae (tunas):					
Gymnosarda unicolor	1	<.5	17.5	<.5	17.5
Triodontidae:					
Triodon bursarius	2	<.5	1.8	<.5	.90
TOTAL	2506		4982.2		

Individuals of this species averaged over 7 kg. Individuals of seven species of snappers accounted for nearly 49% of the catch (2436 kg). Rooseveltia brighami (gindai) was the most abundant fish throughout the surveyed areas, occurring at all but the deepest depths. Although averaging only 1.3 kg/fish, numerically this fish accounted for 32% of the catch, and thus nearly one fourth of the tonnage.

Etelis marshi (ehu), Pristipomoides auricilla (kalekale), P. filamentosus (opaka) and Lethrinus variegatus were also abundant. These fish averaged slightly over 1 kg and were usually in association with gindai. Although not as common, P. flavipinnus (yelloweye opaka) and E. carbuneulus (onaga) were larger than the above species, averaging 2.3 and 6.7 kg in weight, respectively. Groupers (Serranidae) accounted for approximately 10% of the catch by weight. Although caught only occassionally, due to their size (15-25 kg) these fish contributed significantly to the catch. Groupers were generally caught deeper than the jacks and snappers.

The catch composition was fairly uniform throughout the survey area, with depths of 30 to 100 fm proving the most productive. Catches decreased substantially below 175 fm. Only occassional oilfish (Gempylidae), beardfish (Polymixiidae) or spiny dogfish (Squalidae) were caught below 200 fm.

Tables 2 and 3 present fishing location and vertical handline CPUE data for the seamount and island areas, respectively. Fishing time for the seamounts was 452 gear-hours, while 616 gear-hours were spent near the islands. Average CPUE values for the island and seamount areas were 5.6 and 3.1 kg/gear hour, respectively.

CPUE values for the seamounts ranged from 0 to a high of 6.1 kg/gear-hour on Arakane Reef. This reef was fished on three dates and yielded catches

Table 2. Vertical handline, fishing effort and catch data for banks and seamounts surveyed during the Seamount Groundfish Development Project-Guam.

SEAMOUNT	DATE	LOCATION (estimates of large scale chart)	DEPTH	# GEAR HOURS	#kg	kg/hr
58 fathom	8/13-8/15	19^{o}-23'N/145^{o}-28'E	70	60.8	260.9	4.3
C, D, & E	6/28-7/10	area of 17^{o}-36'N/143^{o}-06'E	180-250	28.5	105.9	3.7
Zealandia	8/30	16^{o}-53'N/145^{o}-51'E	40-50	9.5	2.7	0.3
B	6/15-6/22	16^{o}-32'N/143^{o}-07'E	40-200	54.4	112.3	2.1
Arakane	6/1-6/8	15^{o}-38'N/142^{o}-45'E	30-200	70.0	373	5.3
	8/6-8/7		70-150	36.0	108.4	3.0
	1/2-1/6		70-150	40.0	245	6.1
A	5/20-5/27	14^{o}-14'N/142^{o}-52'E	22-160	42.0	23.6	0.6
Rota	7/27-8/1	13^{o}-47'N/144^{o}-57'E	100-170	9.9	17.5	1.8
Galvez	7/25-7/27	13^{o}-00'N/144^{o}-25'E	60-180	17.1	23.5	1.4
	9/17		30-250	4.0	0	0
Santa Rosa	7/15-7/17	12^{o}-51'N/144^{o}-25'E	100	2.0	0	0
	7/22-7/24		100-150	32.5	57.5	1.8
	9/15-9/17		30-350	16.2	32	2.0
	9/19-9/20		60-200	28.8	68	2.4

Table 3. Vertical handline, fishing effort and catch data for islands surveyed during the Seamount Groundfish Development Project - Guam.

APPROXIMATE POSITIONS TAKEN FROM LARGE SCALE CHART	ISLAND	DATE	STATION (# AND LOCATION)	DEPTH	#GEAR HOURS	#Kg	Kg/hr
20°-32'N/144-54'E	Farallon de Pajaros	Nov. 5 - 7	10-around entire island	50-150	20.4	119.2	5.8
		27 - 29	2-southern side	50-120	23	154.5	6.7
20°-01'N/145-13'E	Maug	Nov. 7 - 8	8-northern & southern sides	75-160	32.7	539.2	16.5
		Nov.30 - Dec. 3	5-leeward side & within	75-150	63.6	726.3	11.4
19°-41'N/145-24'E	Asuncion	Nov. 9	5-southern & leeward sides	40-180	20.4	132.1	6.5
		Dec. 4 - 5	2-leeward side	50-175	19.4	114.0	5.9
18°-46'N/145-40'E	Agrihan	Nov.10	6-northern & leeward sides	20-160	15.0	160.7	10.7
		Dec. 6 - 7	2-leeward side	40-150	23	240.5	10.5
18°-09N/145-47'E	Pagan	Aug.16	1-leeward side	80	1.0	0	0
		Oct.23 - 24	2-leeward side	60-100	50	147.7	2.9
		Nov.11 - 12	12-windward & leeward sides	90-160	27	191.2	7.1
		Dec. 8	2-leeward side	75-200	15	18.0	1.2
17°-36'N/145-50'E	Alamagan	Nov.13	2-leeward side	90-150	4.2	1.9	4.
17°-20'N/145-50'E	Guguan	Nov.13 - 14	5-northern & leeward sides	90-140	13.8	183.7	13.3
		Dec. 9 - 10	2-northern side	75-150	29.6	228	7.7
16°-43'N/145-47'E	Sarigan	Nov.14 - 15	5-leeward side	60-100	5.1	229	5.9
16°-22'N/145-41'E	Anatahan	Aug.28 - 29	8-leeward side	30-150	21.3	63.8	3.0
		Nov.15	2-northern side	80-140	3.3	4.2	1.3
16°-01'N/146-04'E	Farallon de Medinilla	Aug.27 - 28	4-northern & leeward sides	50	7.4	34.3	4.6
15°-13'N/145-45'E	Saipan	Aug. 22 - 24	4-leeward side	50-80	18.5	129	7.0
		Sept. 28 - Oct. 3	6-windward side	90-200	30.8	98	3.2
15°-00'N/145-38'E	Tinian	Oct. 3 - 5	5-windward side	80-200	21.2	68.9	3.2
14°-51'N/145-34'E	Aguijan	Oct. 4	2-southern side	110-160	7	16.8	2.4
14°-09'N/145-12'E	Rota	Oct. 11 - 12	4-leeward side	60-140	10.1	40.9	4.0
13°-27'N/144-45'E	Guam	Sept. 21	3-leeward side	100-350	5.8	16.2	2.8
		Dec. 17 - 30	64-drifts made around island	20-200	136.8	42.9	.3

of 3.0, 5.3 and to 6.1 kg/gear-hour. CPUE for "58 fm" bank was 4.3 kg/gear-hour, while those areas near Guam averaged 1.3 kg/gear-hour.

CPUE values ranged from 0 to 16.5 kg/gear-hour for the nearshore island areas. Based on these data, the islands north of Alamagan appear to be the most productive. The islands from Pagan to Farallon de Pajaros averaged 8.2 kg/gear-hour while the islands from Alamagan to Guam averaged 3.0 kg/gear-hour. Maug was substantially the the most productive area. Maug was fished on two dates, and yielded catches of 16.5 and 11.5 kg/gear-hour.

Catches from all other types of gear were negligable. Bottom longlines, vertical setlines and fish traps accounted for less than one percent (36.6 kg) of the total.

Bottom longlines were successfully fished a total of 10.8 hours at seamounts "A" and "B", and Arakane Reef. Depths ranged from 40 to 200 fm. Six fish, weighing 4.6 kg were taken for a CPUE of 0.4 kg/hour. Vertical setlines were fished for 54.4 line hours, primarily in the vicinity of Guam, Rota and Saipan. Gear depth ranged from 30 to 250 fm. Thirty-one (31) fish weighing 28.9 kg were caught, for a CPUE of 0.5 kg/line hour. Vertical setlines would have been effective if schools large enough to warrant the placement and retrieval time had been located. Fish traps (both Hawaiian and Black Cod) were fished a total of 109.3 hours, between 30 and 100 fm. Six fish weighing 3.1 kg (CPUE = 0.03 kg/gear hour) were caught.

Night-light akule fishing was generally poor, with catch rates of usually less than 1 kg per fishing hour. Smalls schools of squid and rainbow runners (Elagatis bipinnulatus) were occassionally attracted to the light, while flying fish (Exocoetidae) were common.

Lobster traps were fished for 161.8 hours and yielded 1 lobster (Panulirus versicolor; 0.6 kg) on Rota Banks. Shrimp pots were fished 96.8 hours, resulting in 2.0 kg of shrimp (Heterocarpis ensifer). These catches occured at a depth of 250 fm on Rota Banks and seamount "B".

Handlines were usually trolled en route to and from the fishing grounds, and incidentally at the fishing areas. A total of 524 fish, weighing 1977.5 kg was caught. Thunnus albacares (yellowfin tuna), Katsuwonus pelamis (skipjack tuna) Acanthocybium solandri (wahoo) and Elagatis bipinnulatus (rainbow runner) collectively accounted for over 82% of the total kilograms of troll catch. Additional catch data is presented in Table 4.

BIOLOGICAL DATA

Individual length, weight and sex data were collected from most of the fish caught. Appendix B presents this information for those species which were most abundant.

Flesh samples were collected from 105 representative fish, for ciquatera toxin analysis. Eighty-four (84) otolith samples were collected for age determination. These analyses are pending, however fish were marketed and consumed without known instances of ciquatera poisoning.

DISCUSSION

Latitude does not appear to influence catch rates or composition on the seamounts but, the shallower seamounts with coral growth seem to hold larger stocks.

The nearshore island waters were more productive than those of the isolated reefs and seamounts. Of these islands, the northern most yielded the greatest catches. However, during the summer of 1978, the RV Townsend Cromwell bottomfished with handlines in the Mariana Islands and on five South

Table 4. Trolling, Catch Composition Data, Seamount Groundfish Development Project - Guam

Family Species	Total Number	Percent of Total Catch By Number	Total Weight (Kg)	Percent of Total Catch By Weight	Mean Weight (Kg)
Carangidae (jacks):					
Caranx lugubris	3	0.6%	16.5	0.8%	5.5
Elagatis bipinnulatus	123	23.5%	293.4	14.8%	2.39
Coryphaenidae (dolphinfish):					
Coryphaena hippurus	28	5.3%	87.2	4.4%	3.11
Istiophoridae (marlin):					
Makaira nigracans	1	0.2%	49.1	2.5%	49.1
Lutjanidae (snappers):					
Lutjanus bohar	2	0.4%	8.1	0.4%	4.05
Scombridae (tunas):					
Acanthocybium solandri	40	7.6%	383	19.4%	9.58
Euthynnus affinus	6	1.1%	33.7	1.7%	5.62
Gymnosarda unicolor	5	0.1%	40.8	2.1%	8.16
Katsuwonus pelamis	179	34%	412.1	20.8%	2.30
Thunnus albacares	112	21%	549.5	27.8%	4.91
Sphyraenidae (barracuda):					
Sphyraena barracuda	24	4.6%	104.1	5.3%	4.34
S. picudilla	1	0.2%	-		
TOTAL	524	98.6	1977.5	100	

Honshu Seamounts (NMFS, 1978). Although catch composition was similar, somewhat higher catch rates were obtained on the seamounts (1.89 fish/line-hour) than near the islands (1.03 fish/line-hour).

Catch rates for this survey were low, and undoubtedly too low to support vessels comparable to the Typhoon. No large stocks of fish were located and no evidence of the occurrance of alfonsin within the study area was found. Latitude and water temperature may be an explanation for the absence of alfonsin. This survey was conducted between 12°N and 20°N, while all commercial alfonsin fisheries occur above 30°N. Although temperature preferences are not known for this species, cooler waters and higher thermoclines would be expected at higher latitudes than within this survey area. Also, habitat could be limiting. Compared to the known alfonsin grounds of northwest Hawaii, the surveyed seamounts are very small and widely distributed. The largest, surveyed seamount is approximately 2 miles in diameter, while many of the Hawaiian seamounts are many square miles. Although alfonsin also occur on the smaller Hawaiian seamounts, the proximity of these small mounts to larger grounds may be a factor in establishing and maintaining the stocks. Presumably, schooling groundfish would require a minimum amount of supporting habitat, which the South Honshu Seamounts may not supply.

The grounds of the surveyed area may, however, hold potential for a small scale fishery. In light of the state of the fishing industry on Guam and the NMI, this potential should be explored. Although catch rates were low, these would be expected to improve at least initially, as concentrated fishing efforts improved techniques and knowledge of the grounds. Also, it should be noted that although the personnel of the Typhoon are competent seamen and proven albacore fishermen, the project lacked a qualified bottomfish fisherman.

Nonetheless, the resources are limited and widely distributed, so high operating expenses would be a major factor. If these cost could be reduced, perhaps with motor/sailing fishing vessels, several small operations may be able to operate profitably.

Few areas were fished repeatedly or extensively, therefore the ability of these stocks to withstand heavy pressure is not known. It is generally believed that on small banks, target species are eventually reduced with a concurrent increase in less desirable species (Shomura, per. comm.). During a previous survey (Ikehara et al., 1970) a small pinnacle near Guam was fished repeated for a period of 14 months. A total of 3,322 kg of fish were taken, however CPUE decreased from 13.8 to 1.3 kg/line-hour.

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ACKNOWLEDGEMENTS

The assistance and cooperation provided by Stan Weinberg (PTDF) and Keith Coburn is greatly appreciated.

Appendix A

Vessel Specification

FV TYPHOON

Captain:	Keith Coburn
Navigators:	Rich Hayes and Jerry Grimm

Vessel Length	74 feet 6 inches
Beam	38 feet
Gross Tonage	90 tons
Net Tonage	46 tons
Fish Capacity	50 tons
Fuel Capacity	10,000 gal
Cruising Speed	7.5 knots
Fuel consumption at cruising speed	approximately 8 gal per hour
Navigation Equipment	Loran C, Omega

Fishing vessel, Typhoon.

Appendix B. Length, Weight and Sex Data of Selected Species, Seamount Grounfish Development, Guam

	Fish Sampled	Length Range (cm)	$\bar{X}$ Length (cm)	Weight Range (Kg)	$\bar{X}$ Weight (Kg)	Sex Ratio (M:F)
Carangidae (jacks):						
Caranx lugubris	178	31.5-79.5	50.0	0.6- 9.7	3.02	2:1
Seriola purpurascens	27	32.2-98.0	71.3	0.8-13.0	6.30	4:1
Lutjanidae (snappers):						
Etelis marshi	162	22.0-55.0	34.4	0.1- 3.4	0.81	.85:1
Lethrinus variegatus	17	30.1-38.5	34.9	0.6- 1.1	0.85	1.0
Pristipomoides auricilla	69	27.0-40.5	35.2	0.3- 1.4	0.83	.65:1
P. flavipinnus	48	36.0-65.7	50.4	0.7- 4.6	2.26	2:1
Rooseveltia brighamii	414	21.0-49.5	37.9	0.3- 2.3	1.21	.66:1

APPENDIX C

1980 LONGLINE AND BOTTOM FISHING SURVEY OF GUAM AND NORTHERN MARIANAS

By Keith F. Coburn

The Pacific Tuna Development Foundation (PTDF) chartered the fishing vessel Typhoon out of Honolulu, Hawaii to make a survey of the potential for commercial bottom longline, reeled handlines and trap fishing covering seamounts and pinnacles. The Typhoon left Honolulu on April 28th and arrived in Agana harbor Guam on May 17th. A calm passage with stern winds was experienced the whole trip. Trolling was done with very few surface fish caught. On arrival in Guam open house to all interested parties was conducted showing boat, gear and traps. Meetings were held with Harry Kami, Chief of Aquatic and Wildlife Resources Division Govt. of Guam. Mr. Kami outlined the cruise objectives and banks and seamounts to be surveyed and fished. After a three day period in port, the Typhoon sailed on its first assignment to the banks west northwest of Guam. At that time, a storm with ninety mile winds developed close to Guam. The Typhoon returned to port and left again on the 22nd for the first objective. Problems developed with the first bottom longline drops. We found our method of anchoring one end and of hooking on branch lines or droppers entailed to much time and caused extreme tangling of the main line. Also, the area being set on were pinnacles with very small top area and almost impossible to anchor on. The longline would stretch over the edge of the pinnacle or seamount and as it sank to lower depths became entangled on the coral bottom. Many tries were made with an immense amount of gear being lost.

We then turned to another method of fishing. A single bouy with main line and anchor extending down to the bottom and branch lines spaced from anchor up at different settings. This produced some fish but did not produce in commercial quantities. Three hydraulic hand line pullers located on the port rail proved to be the best method of sampling the potential while drifting over the seamounts. Anchoring on the seamounts was effected at depths of 100 to 200 fathoms. This took time and was extremely difficult as to placement over the area to be fished. In almost every exercise in anchoring we were frequently unable to put ourselves in a good position. The loss of anchors, chain, cable and heavy nylon line became a real problem to the contractor and a real monetary loss.

Our succeeding trips were confined to the row of offshore banks lying off Guam and extending parallel to the Marianas Islands up to Sting Ray shoals, which lie about 150 miles west of the Island of Farallon de Pajaros the northern most Island of the Marianas chain. We found all of these offshore seamounts or pinnacles to have very small areas near the surface. Some of the Marine charts showed seamounts with a five mile top contour. We found them to be at times only a quarter of a mile. Tops of the seamounts varied from 30 feet to 1200 feet from the surface. On these trips to the offshore banks only one produced an amount of fish. That was Arakane Reef, 171 miles from Guam. During this period of the charter surface, fish were caught such as Skipjack, Yellow Fin Tuna, Rainbow Runners, and Wahoo. Bottom fish caught were Snappers, Groupers, Paka Paka, Gindia, Kahala, and Onaga. Fishing was done in depths of 50 fathoms to 300 fathoms. At depths of over 1200 feet or 200 fathoms we found very few fish and none of commercial value.

On all offshore banks or seamounts hundreds of drops were made with hydraulic hand lines to all depths. Bouyed long lines and bottom longlines were employed besides shrimp and lobster pots. No lobster or shrimp potential was found. One of the principle varieties of bottom fish that was stressed in the charter prospectus was Alfonsin. We found no Alfonsin in this area.

After a thorough search on the offshore banks the Typhoon started with Santa Rosa Banks below Guam and worked north covering grounds around the Islands of Rota and Tinian. Then on to Saipan and on succeeding trips to the Islands of Farallon de Medinilla, Anatahan, Sarigan, Zelandia Banks Guguan, Alamagan, Pagan, Agrihan, Asuncion, Supply Reef, Maug Islands and Farallon de Pajaros the top Island of the Northern Mariana chain. In the various trips we made north, the bird life increased many fold and fishing effort was very rewarding. In all of our search we enjoyed the best catches from 20 degrees northward. Cooler water temperatures, more prolific bird life and bait fish were in evidence. At the period we were fishing this northern area, we witnessed no real fishing effort by local canoes or boats. The Islands to the north are sparsely populated and some not at all. At several instances foreign longliners and bait boats were sighted. These were reported, when possible, to the U.S. Coast Guard. Farallon de Pajaros is volcanic and active with steam or smoke still being emitted. Other Islands of same origin are dormant. Most are covered with vegetation and cocunut trees. The only fair anchorage is in the Maug Island Group.

The last part of the charter was spent in a survey of the banks around Guam and around the island itself. We failed to find any real commercial concentration of fish that would support large boats. In this statement I do not include the possibility that a longline fishery does exist for Tunas and Billfish. We did not survey that fishery. We have seen foreign fishing boats working, so must conclude a fishery exists. During the charter the Typhoon delivered over ten thousand pounds of fish to the local Fisherman's Cooperative. Some was sold from the boat and a certain amount was given away. The sales averaged about one dollar a pound. In conclusion of this report, I wish to thank Harry Kami for his support and the observers that were aboard during our stay, I also wish to commend Stan Weinberg, (PTDF) supervisor, for his help through out the charter. We did not have all smooth sailing as several tropical storms passed thru and disrupted our plans. Our bottom longline effort did not produce what we expected. We believe that hydraulic hand lining proved the best method of bottom fishing because of the extremely rough coral bottom. The fish production is good as you proceed up in the Northern Marianas. I believe a potential does exist in that area. I do not believe a bottom fishery exists around Guam for a large fleet of large boats. Small boats in the 20 to 40 foot size can make it, if fished as a commercial project. Not as a weekend affair.

Fish prices are adequate and the Fish Cooperative could survive in better shape with better funding and several full time fishermen and fish boats delivering to them. I believe that a longline fishery could exist in the 25 to 40 foot size boat that could deliver for the fresh market. It's done in Hawaii by that size of craft. The market in Saipan seems to be good and could stand more deliveries of fish. The Northern Marianas could deliver and supply that market. As it is now, a great influx of fish is shipped in from the Philippines. We also found that frozen fish will sell well in Guam if properly handled and frozen fast under a low temperature. We received many compliments on quality of frozen fish sold. Again, I must stress that we do not think any Alfonsin exists in the warm waters of the Marianas. This fish is usually found in cooler water temperatures found around seamounts above 30 degrees north. In this report I have not included specific areas nor fish catch rates. The Aquatic and Wildlife Resources of Guam under Harry Kami has this information available to future charters or fishing vessels intending to work the Mariana Islands. One must take into consideration the weather involved, such as storms of typhoon strength; humidity that will cause trouble with the best of electronics; a real lack of marine supplies for larger boats and fuel, oil and dockage that are higher than most ports. We received the finest help and cooperation from the Port of Guam and Shipping Agencies Aquatics Division, Harry Kami and his men and Joaquin P. Villagomez, Chief of Marine Resources on Saipan.

At last I will express a personal observation and recommendations:

1 - A need for people who wish to make fishing a full time occupation.

2 - A means for them to procure boats in the 25 to 40 foot size with adequate commercial fishing gear.

3 - A place to dock and unload fish and obtain fuel and supplies.

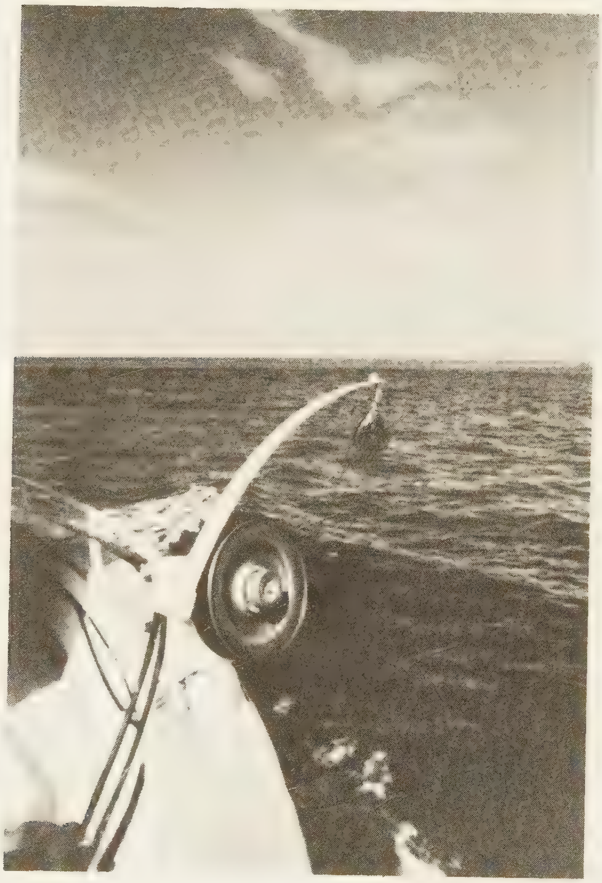
4 - Fish Cooperative or others with zero refrigerated storage.

5 - Ice chopper and blower to put ice aboard.

A steady supply of fish is mandatory so some must be sold fresh and some frozen to carry over during periods that catch rate is low.

Fishermen who earn their living from fishing do not wish a gift, they only need a means to establish their own business.

Boat Typhoon
Keith F Coburn



Hydraulic vertical handline

PROJECT TITLE: Fourth Annual Marianas Fishing Derby

PERIOD COVERED: July 19-21, 1980

INTRODUCTION

The annual Marianas Fishing Derby (MFD) held at the Agana Boat Basin has become an established summertime event on Guam. The organization and execution of this year's contest was testimony to the Guam Fishing and Boating Association's (GFBA) committment to develop the MFD in a progressive and comprehensive manner. An increase in the cooperation among participating anglers was also evident during the brief check-in/check-out phases with the derby officials, as well as during the more time-consuming catch examination process with fishery biologists from the Aquatic and Wildlife Resources (AWR) Division. The GFBA'S positive committment and an increasingly cooperative attitude among MFD participants will undoubtedly contribute to the continuing success of this event, and especially to the enjoyment derived by everyone involved.

The rules for the fourth annual MFD were modified only slightly from those of last year. They are provided in Figure 1. The most significant change concerns Rule No. 10. Specifically, the 1980 MFD Committee's interpretation of Prize Category 5 determined that the award be presented to the angler who lands the "largest total number of all categories" in kilograms of fish rather than in numbers of individuals.

PARTICIPATION

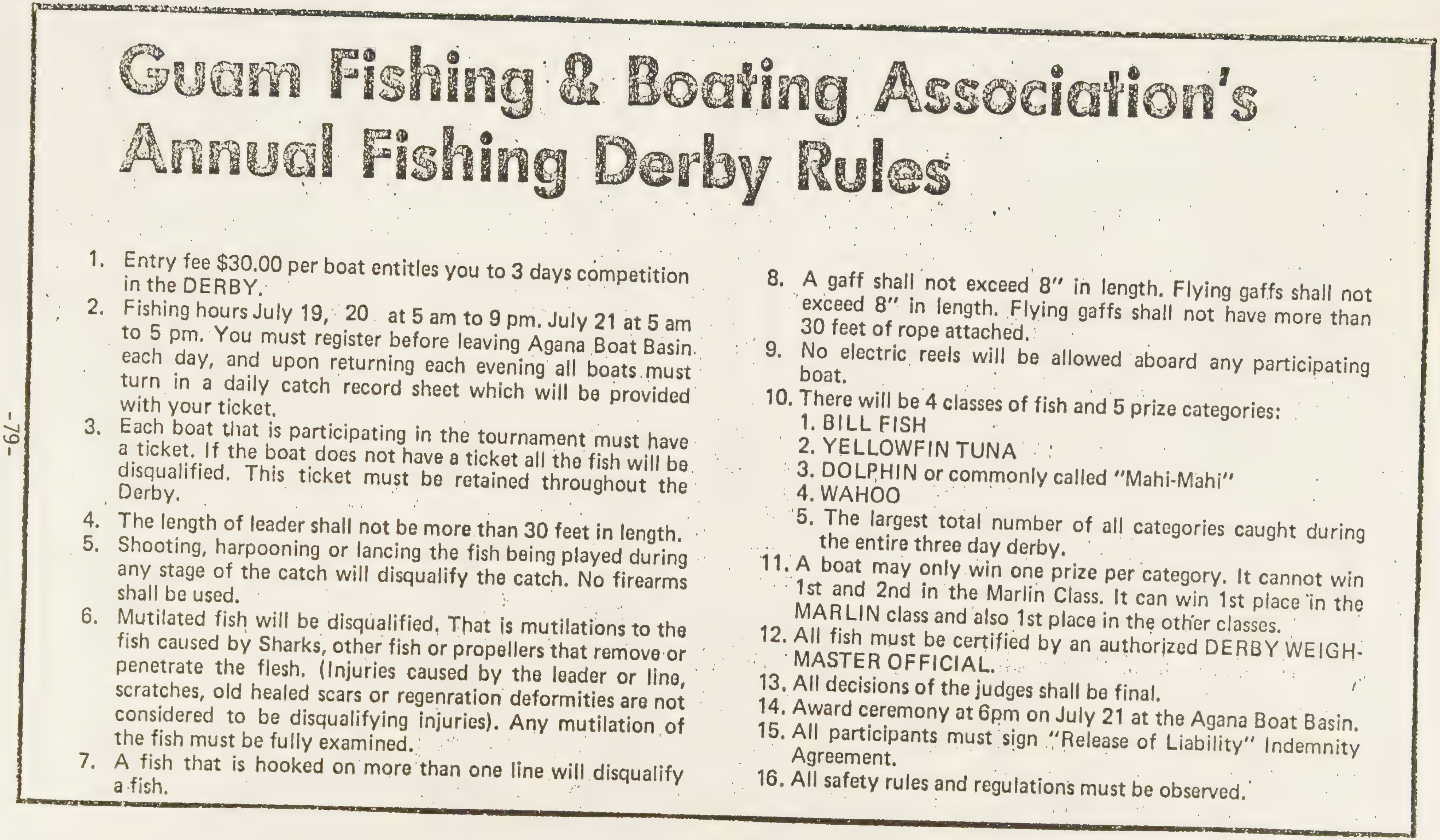
Although the weather during the 1980 MFD was favorable, participation fell a sharp 27% from that of last year. It is speculated that increasing petroleum costs and the current inflationary condition of our economy were the primary cause of the observed decrease in participation.

A total of 86 separate boat trips were made by 264 anglers during the three-day event (Table 1). Each boat carried an average of three anglers, who spent an estimated 2,586 person-hours of fishing effort. Since each boat trolled an average of 4.7 fishing lines, expended effort may also be viewed as approximately 3,920 line-hours of fishing time.

THE CATCH

This year a total MFD catch of 77 fish weighing 1,235.5 kg were censused. The daily catch is summarized by its component species in Table 2. Twelve blue marlin within a weight range of 40.2 - 139.3 kg were landed during the three-day contest. They totaled 727.2 kg, with a mean weight of 60.6 kg.

Fifty yellowfin tuna were also landed. Their weight range ran from 1.9 to 51.1 kg. They weighed a total of 307.7 kg, with a rather low mean of 6.2 kg. It was interesting to find that only six of the yellowfin weighed more than 15.0 kg, but that these accounted for nearly 53% of the total weight landed for this species.



Guam Fishing & Boating Association's Annual Fishing Derby Rules

1. Entry fee $30.00 per boat entitles you to 3 days competition in the DERBY.
2. Fishing hours July 19, 20 at 5 am to 9 pm. July 21 at 5 am to 5 pm. You must register before leaving Agana Boat Basin each day, and upon returning each evening all boats must turn in a daily catch record sheet which will be provided with your ticket.
3. Each boat that is participating in the tournament must have a ticket. If the boat does not have a ticket all the fish will be disqualified. This ticket must be retained throughout the Derby.
4. The length of leader shall not be more than 30 feet in length.
5. Shooting, harpooning or lancing the fish being played during any stage of the catch will disqualify the catch. No firearms shall be used.
6. Mutilated fish will be disqualified, That is mutilations to the fish caused by Sharks, other fish or propellers that remove or penetrate the flesh. (Injuries caused by the leader or line, scratches, old healed scars or regenration deformities are not considered to be disqualifying injuries). Any mutilation of the fish must be fully examined.
7. A fish that is hooked on more than one line will disqualify a fish.
8. A gaff shall not exceed 8″ in length. Flying gaffs shall not exceed 8″ in length. Flying gaffs shall not have more than 30 feet of rope attached.
9. No electric reels will be allowed aboard any participating boat.
10. There will be 4 classes of fish and 5 prize categories:
    1. BILL FISH
    2. YELLOWFIN TUNA
    3. DOLPHIN or commonly called "Mahi-Mahi"
    4. WAHOO
    5. The largest total number of all categories caught during the entire three day derby.
11. A boat may only win one prize per category. It cannot win 1st and 2nd in the Marlin Class. It can win 1st place in the MARLIN class and also 1st place in the other classes.
12. All fish must be certified by an authorized DERBY WEIGH-MASTER OFFICIAL.
13. All decisions of the judges shall be final.
14. Award ceremony at 6pm on July 21 at the Agana Boat Basin.
15. All participants must sign "Release of Liability" Indemnity Agreement.
16. All safety rules and regulations must be observed.

Figure 1. Official 1980 Fishing Derby Rules

Table 1. Daily Participation in the 1980 Marianas Fishing Derby.

Date	No. Boats	Avg Trip Hrs.	No. Persons	Avg Pers/Boat	No. Lines	Avg Lines/Bt.
19 July	37	10.2	110	3.0	171	4.6
20 July	24	9.8	75	3.1	125	5.2
21 July	25	8.9	79	3.2	106	4.2
TOTAL	86	9.7	264	3.1	402	4.7

Table 2. Daily Catch for the 1980 MFD.

	Blue Marlin		Yellowfin		Mahimahi		Wahoo		Total	
Date	No.	Kg	No.	Kg	No.	Kg.	No.	Kg.	No.	Kg.
19 July	4	202.0	30	216.6	0	0.0	6	74.6	40	493.2
20 July	2	199.5	16	75.9	1	15.9	3	40.0	22	331.3
21 July	6	325.7	4	15.5	2	23.4	3	46.6	14	411.0
TOTAL	12	727.2	50	308.0	3	39.3	12	161.0	77	1,235.5

Table 3. Sex Ratios and Mean Weights for 45 of the 77 Fish Caught During the 1980 MFD.

	Males		Females		Ratio
Species	No.	$\bar{X}$ wt.	No.	$\bar{X}$ wt.	Males : Females
Blue Marlin	9	54.7	2	97.5	4.5 : 1
Yellowfin	17	5.3	4	21.5	4.2 : 1
Mahimahi	1	15.9	2	11.7	0.5 : 1
Wahoo	2	8.1	9	13.8	0.2 : 1

The mahimahi catch was characteristically low again this year. The three individuals which were caught weighed a total of 39.3 kg, with a mean of 13.1 kg. These had a weight range of 11.4 - 15.9 kg.

Wahoo contributed 161.0 kg of the total derby catch. The 12 individuals weighed between 7.0 and 23.4 kg, with a mean weight of 13.4 kg. This year's first place wahoo set a new MFD record in this species category.

SEX RATIOS

The gonads of forty-six derby fish were examined. The results are listed in Table 3. As usual, the blue marlin and yellowfin tuna male: female ratios were very close at 4.5:1 and 4.2:1, respectively. However, in past derbys these two species were found to exhibit sex ratios near 1:1. For this reason it was interesting to find ratios more typical of those determined for the same species at the Hawaiian International Billfish Tournament held each year in Kona, Hawaii.

Also, as in past MFD's, females dominated both the mahimahi and wahoo catches. Their ratios this year were 0.5:1 and 0.2:1, respectively. Overall, for the four species combined, a sex ratio of 1.7:1 was determined. This is very close to the overall ratio of 1.5:1 found at last years MFD.

FISHING AREAS

This year general strike areas for the 77 derby fish were compiled from the information provided by the derby participants. These data are presented in Table 4. The fishing areas on this table may be identified on the map in Fig. 2.

As expected, Area 4 (Rota Banks) and Area 24/25 (Ritidian Pt), were the most productive regions providing 21.8% and 20.4% of the total catch by weight, respectively. Area 17, northwest of the island produced 15.1% of the total catch due to the landing of two blue marlin, including the first place finisher.

In terms of numbers of fish, 40.2% of the total derby catch came from Area 4 alone, while 16.9% came from Area 24/25. Only one fish each was caught within several of the reported fishing areas. These included Areas 9, 39 and 71, which produced the first place wahoo, yellowfin tuna and mahimahi, respectively.

STOMACH CONTENTS

The same 4 fish used to obtain data on sex ratio were also examined for stomach contents. Surprisingly, only three fish (6.7%) were found to have empty stomach chambers (Table 5). Two of these were blue marlin, the other a wahoo. Based on experience gained at past derbies we expected to find the majority of empty stomachs among the wahoo; yet, all but one of this year's wahoo contained food material of some sort.

The most ubiquitous food item was fish, occurring in 37 (82%) of the 45 samples. Invertebrates were found in stomachs from all four species, but were particularly significant within the yellowfin samples (95%). This was

Table 4. Number of Fish Entered for Prizes by Species, Date and Area of Catch During the 1980 MFD (Also See Fig. 2).

	2	4	9	11	12	14	17	18	19	23	24/25	29	32	39	51	56	70	71	85	TOTAL
BLUE MARLIN:																				
19 July	-	2					-	-	1		1	-			-					4
20 July	1	-					1	-	-		-	-			-					2
21 July	-	-					1	1	-		2	1			1					6
TOTAL	1	2					2	1	1		3	1			1					12
AVG WT (Kg)	60.2	49.4					92.6	50.0	47.5		62.8	40.7			48.4					60.6
YELLOWFIN:																				
19 July		18			1	7		1	1		-			1		-			1	30
20 July		4			-	-		-	-		8			-		4			-	16
21 July		4			-	-		-	-		-			-		-			-	4
TOTAL		26			1	7		1	1		8			1		4			1	50
AVG WT (Kg)		4.5			2.6	2.3		26.1	4.8		5.4			51.1		3.9			27.3	6.2
MAHIMAHI:																				
19 July												-					-	-		-
20 July												-					-	1		1
21 July												1					1	-		2
TOTAL												1					1	1		3
AVG WT (kg)												12.0					11.4	15.9		13.1
WAHOO:																				
19 July		2	-	1				-		-	2		1							6
20 July		1	-	1				1		-	-		-							3
21 July		-	1	-				-		1	-		1							3
TOTAL		3	1	2				1		1	2		2							12
AVG WT (Kg)		14.1	23.4	8.2				18.9		8.3	10.0		15.6							13.4
No. Caught	1	31	1	2	1	7	2	3	2	1	13	2	2	1	1	4	1	1	1	77
% Total No.	1.3	40.2	1.3	2.6	1.3	9.1	2.6	3.9	2.6	1.3	16.9	2.6	2.6	1.3	1.3	5.2	1.3	1.3	1.3	100.0
Kg Caught	60.2	269.8	23.4	16.4	2.6	16.1	185.2	95.0	52.3	8.3	252.6	52.7	31.2	51.1	48.4	15.6	11.4	15.9	27.3	1,235.5
% Total Kg	4.9	21.8	1.9	1.3	0.2	1.3	15.1	7.7	4.2	0.7	20.4	4.3	2.5	4.1	3.9	1.3	0.9	1.3	2.2	100.0

MARIANAS FISHING DERBY
FISHERMEN"S CATCH RECORD

BOAT: ____________ DATE: __________ CHECK OUT: __________ CHECK IN: __________

NUMBER OF FISHERMEN: 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐

NUMBER OF LINES: 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐

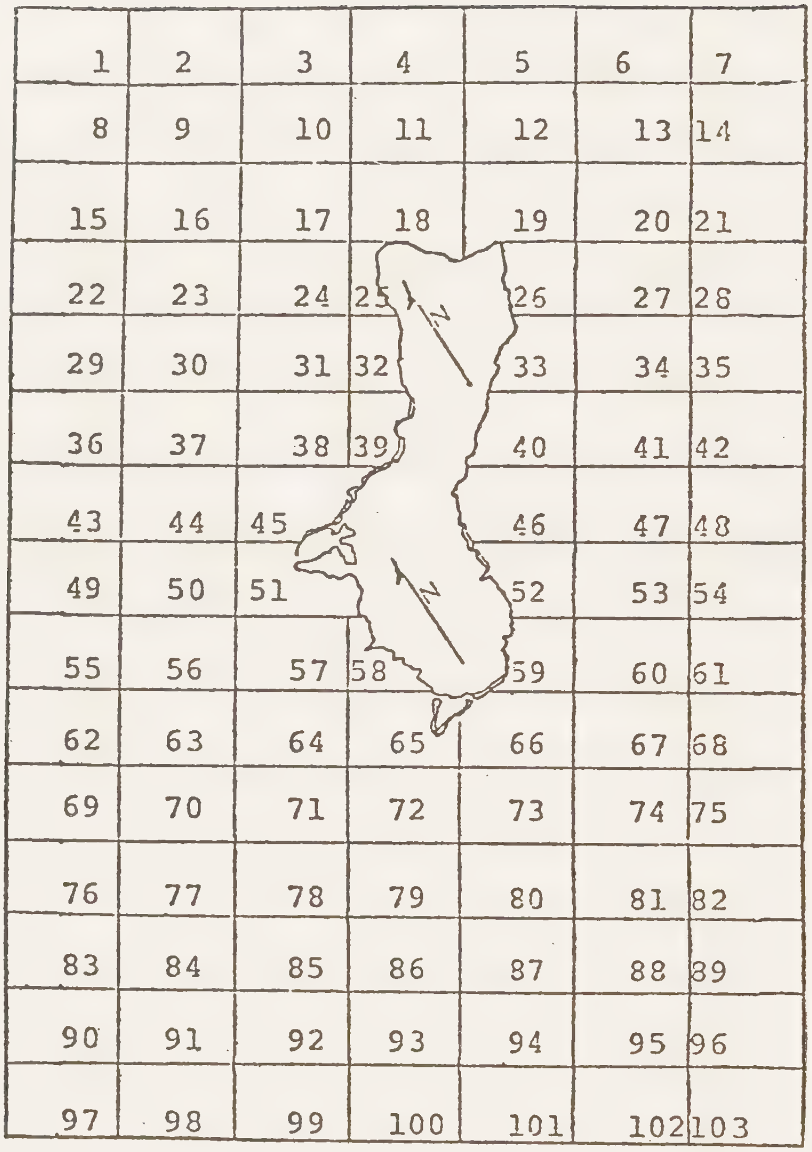
LOST TIME: __________ PORPOISE TODAY? NO ☐ YES ☐ AT: ______________

SPECIES	# CAUGHT	TOTAL WEIGHT	FISHING AREAS
TOTAL CATCH:			
MARLIN			
MAHIMAHI			
YELLOWFIN			
WAHOO			

	AREA	STRIKE	FIGHT	LN (cm)	WT. (kg.)	SEX	GUT
MARLIN							
MAHIMAHI							
YELLOWFIN							
WAHOO							

TOTAL WEIGHTS ARE: ☐ ESTIMATED ☐ ACTUAL SCALE WEIGHTS
INDIV. WEIGHTS: ☐ ESTIMATED ☐ ACTUAL SCALE WEIGHTS

Figure 2. Daily Catch Record Use During the 1980 MFD.


1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31 32 33 34 35
36 37 38 39 40 41 42
43 44 45 46 47 48
49 50 51 52 53 54
55 56 57 58 59 60 61
62 63 64 65 66 67 68
69 70 71 72 73 74 75
76 77 78 79 80 81 82
83 84 85 86 87 88 89
90 91 92 93 94 95 96
97 98 99 100 101 102 103
N
N

FISHING AREA NUMBERS;
FILL IN ON OTHER SIDE
GRID SCALE:
APPROX. 5 mi. x 8mi.
4 = Rota Bank
12 = 45^{o} Bank
24/25 = Ritidian Pt.

19 = Pati Pt.
25 = Uruno Pt.
39 = Hospital Pt.
51 = Orote Pt.
70 = 11mi. (17mi.) Reef
85 = Galvez Bank
100 = Santa Rosa Reef

Figure 2. Continued

Table 5. Food Items and Their Occurrence in 45 Gut Samples Taken At the 1980 MFD, By Species of Fish.

FOOD ITEMS	No. Of Stomachs Containing Listed Food Items				
	Blue Marlin	Yellowfin	Mahimahi	Wahoo	All Spp.
FISH:	9	18	2	8	37
Acanthuridae	4	6	0	1	11
Balistidae	1	2	0	1	4
Belonidae	2	0	0	0	2
Carangidae	1	3	0	1	5
Clupeidae	1	0	0	0	1
Dussumieridae	2	2	0	0	4
Echeneidae	0	0	0	1	1
Exocoetidae	1	0	0	0	1
Gempylidae	0	2	1	2	5
Menidae	2	2	0	1	5
Monacanthidae	1	3	0	1	5
Ostraciontidae	0	5	1	2	8
Scombridae	4	0	0	2	6
Tetraodontidae	1	2	0	0	3
Unidentified Fish	5	14	2	4	25
INVERTEBRATES:	3	20	1	5	29
Squid	3	9	1	4	17
Shrimp	2	19	0	2	23
Crustacean Larvae	0	4	0	0	4
Isopod	0	1	0	0	1
Mite	0	1	0	0	1
Argonaut	0	1	0	0	1
NO. STOMACHS	11	21	2	11	45
NO. EMPTY	2	0	0	1	3
% EMPTY	18.2	0.0	0.0	9.1	6.7

largely due to the presence of shrimp. Also, the data suggest that both fish and invertebrates are desirable and available food items for the yellowfin tuna in our surrounding waters.

In past derbies, the trematode Hirundinella sp was found only in wahoo samples. This year the internal parasite was found in eight blue marlin (73%) and three yellowfin (14%) as well as in all of the wahoo sampled. One wahoo landed this year actually contained a total of 22 of these organisms.

REMARKS

Participation in this year's MFD was relatively low, but in terms of efficient execution it was definitely a success. The GFBA, especially the MFD Committee chaired by Mr. Gregorio Camacho, should be commended for a job well done. From AWR's standpoint, they made our work at the derby much easier than it has been in the past. By enlisting help from their membership to move fish back and forth between boat and scale, they freed the fishery biologists to concentrate exclusively on the weighing and examination of the catch as it came in. Their help in this regard greatly reduced the amount of time each boat had to spend at the scale, particularly during the "rush hour" traffic jam at the end of each fishing day. This, in turn, kept confusion down for the biologists and derby officials, and spared the participating anglers any unnecessary time spent before they were allowed to disembark for the day.

The fifth annual MFD will be held during the summer of 1981. In our next annual report we will present an analysis of the data obtained at that contest as well as a cumulative analysis of the MFD data collected over the past five years.

Report prepared by **Michael E. Molina**

Prize winning marlin

Fisheries biologists measuring fish for biological data.

PROJECT TITLE: FISH WEIR REPORT

PERIOD COVERED: October 1, 1979 to September 30, 1980

The operators of the six fish weir sites permitted for FY-80 submitted 60 monthly catch reports. One of these operators never established his weir so the 60 reports received represent 100% of the total number of catch reports we could expect. Because of this, we are presenting actual data without the expansions employed in previous reports.

The total annual fish weir harvest on Guam during FY-80 amounted to approximately 8,413 kg. Goatfish (Mullidae) accounted for 28% of the total or 2,355 kg, followed by 1,459 kg of snappers (Lutjanidae) and 1,024 kg of jacks (Carangidae). A summary of the catch totals is presented in Table 1.

Report prepared by R. Logan Kock

Table 1 Reported Fish Weir Harvest in Kilograms, by Fish Family for FY 80. Atulai (*Trachurops crumenopthalmus*; family Carangidae) is included as an individual species.

Family	Reported Catch (kg)	Percent (%) of Total Catch
Acanthuridae (surgeon fishes)	305	4
Carangidae (jacks)	1024	12
T. crumenopthalmus (atulai)	396	5
Leiognathidae (soapys)	652	8
Lutjanidae (snappers)	1459	17
Mugilidae (mullets)	711	8
Mullidae (goatfish)	2355	28
Serranidae (groupers)	108	1
Siganidae (rabbit fishes)	265	3
Other Assorted Species	1138	14
TOTAL	8413 kg	100%

GUAM FISHERIES DEVELOPMENT
PROJECT F-2-D-2
Federal Aid in Sport Fish Restoration Act

PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-2
SUB-PROJECT NO.: FD-1

SUB-PROJECT TITLE: Masso Reservoir Development

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Stocking of Masso Reservoir was initiated with the introduction of 400 local, hybrid tilapia. Approximately 200 trees were planted in the watershed in an attempt to reduce erosion and siltation. Management of Masso Reservoir and the adjacent acreage is currently being transferred to the Department of Parks and Recreation.

BACKGROUND

Fishing continues to be an important activity for many people on Guam. It is highly valued as a recreational activity and remains an important source of food. Saltwater fishing is available but, there is no standing body of freshwater accessible to the general public. If a fishable freshwater pond was available, it would be unique in providing fishing opportunities for the very young, senior citizens, and handicapped people who are unable to fish in the ocean where high waves and strong currents are often present.

The Masso Reservoir was constructed by the U.S. Navy in the early 1940's for use as a potable water reservoir. It was abandoned in 1951 because siltation had made it unsuitable for water storage. Siltation continued until only a ¼-½ acre area of open water existed, surrounded by a marsh of elephant grass (Phragmites karka). The reservoir and surrounding area became overgrown and forgotten except for an occasional eel or shrimp fisherman setting traps in the reservoir or feeder streams.

In 1978, the Black Construction Company, working under contract to the Aquatic and Wildlife Resources Division, cleared about two acres of the pond by removing the Phragmites grass. At this time the retaining wall, spillway, and sluice gate were repaired. When full, the pond has an open water surface area of about two and one half acres and a maximum depth of about eight feet. There remain another two acres of marsh habitat at the mouths of the two tributaries which empty into the reservoir.

Aquatic organisms found in Masso Reservoir and its feeder streams include two eels (Anguilla mormorata and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis), an eleotrid (*Elotris fusca*), several shrimps (*Atya* sp., *Caridina* sp., and *Macrobrachium lar*), tadpoles of *Bufo marinus*, and a variety of insect larvae and small invertebrates. The vegetation is dominated by the reed *Phragmites karka* in wet areas, and by *Leucaena leucocephala* (tangan-tangan) on dry ground. Other trees in the area include *Hibiscus tiliaceus*, *Pandanus* sp., *Spathodea campanulata* (African tulip), *Casuarina equisetifolia* and *Pithecellobium dulce*.

Between July and December of 1978, YCC and CETA personnel planted hundreds of trees and shrubs on the hillsides of the Masso watershed. A detailed description of this work was included in the 1979 Aquatic and Wildlife Resources Report.

In March, 1978, a Draft Environmental Impact Statement for the introduction of exotic fish into Masso Reservoir was submitted to the U.S. Fish and Wildlife Service (FWS). Under this proposal, approximately 20 species of exotic game and forage fish would have been planted. However, the DEIS was reviewed by the FWS and found to be inadequate in its treatment of the potential problems. It was suggested that the required process to complete an acceptable EIS would be far more time consuming and costly than the project warrants. In view of this attitude adopted by the FWS, and after considering the numerous professional evaluations of the stocking, it was decided not to stock the Reservoir with exotic species.

OBJECTIVES

The objectives of the Masso Project have included the following:

1. Create a pond with several acres of open water suitable for stocking with forage and game fish;
2. Repair the retaining wall, spillway and sluice gate;
3. Create a variety of fish habitats within the pond with brush shelters, rock piles, etc.;
4. Fence in the spillway area to remove an "attractive nuisance" which is potentially dangerous to children and others;
5. Landscape the area around the pond, and plant attractive fruit, shade, and ornamental trees and shrubs;
6. Stock the pond with fish;
7. Monitor the fish populations in the pond, and the fishermen's use of the pond.

FINDINGS

As an alternative to the proposed stocking of exotics, Masso Reservoir is currently being stocked with local tilapia. On November 5, 1980, 400 red, male, hybrid tilapia averaging approximately 15 cm in total length and 50 g in weight were placed in the pond. These tilapia result from hybridization of *Sarotherodon mossambica* and *S. nilotica*, and are currently being raised commercially on Guam by two aquaculture companies. Offspring of this hybridization are referred to as "cherry snapper" and are mottled or uniform red and predominantly male. Both attributes make this hybrid advantageous for stocking in Masso. Red is a locally preferred color for fish and monosex stocking should reduce the common problem of stunted fish due to overpopulation. Although each fish was sexed prior to its release we realize that 100% accuracy is rarely obtainable, and some reproduction is expected. A total of 3,000 fish will eventually be stocked. Stocking should be continued to replace those fish removed by angling.

Erosion of the surrounding land and the resultant siltation of the Reservoir continue to be a problem. To help alleviate this problem additional plantings of shade and fruit trees were made during September and November 1980. Approximately 200 trees were placed in the watershed by CETA and YCC personnel.

The Masso Reservoir and immediately adjacent land (26 acres) is currently being transferred to Government of Guam ownership and will be managed by the Dept. of Parks and Recreation. Ultimate plans call for the development of picnic, camping and hiking facilities, in conjuction with the recreational hook and line fishing.

RECOMMENDATIONS

Stocking of Masso Reservoir with monosex, hybrid tilapia should be continued. Once the fish have become established the pond should be opened for public fishing. Periodic restocking of the pond will be necessary. Under the management of the Department of Parks & Recreation, picnic and hiking facilities should be provided.

Report prepared by Alan J. Hosmer

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-2
SUB-PROJECT NO.: FD-2a

JOB TITLE: Construction of Fish Aggregating Devices

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Three Type I and five Type II fish aggregating devices (FAD'S) were constructed during FY 80. Of these, two Type I and one Type II FAD'S were deployed. One Type I that broke loose was redeployed. Thus far all buoys deployed have broken loose due to problems with the ground tackle design and materials. Because some of the lost FAD'S were recovered the net loss is two.

Two methods are used to assess the effectiveness of the FAD'S at Guam, fishermen interviews (as part of the regular creel census program) and visual observations using SCUBA. An estimated 180 visits were made to one FAD during a two month period amounting to an estimated catch of 700 kgs. Data on the other buoys is less detailed. Visual observation identified many fish species associated with buoys.

BACKGROUND

Cork rafts in Malta and bamboo rafts in Japan and the Philippines have been used for centuries by fishermen to aggregate coastal pelagic fishes and improve their catches. Dispensable rafts such as these are so widely used in some Asian countries that the National Marine Fisheries Service in Hawaii decided to experiment with the concept using permanent moored offshore fish aggregating devices (FAD). The pilot began in 1977. Its objective was to determine if it was possible to attract, aggregate and hold pelagic fish schools in its vicinity and improve catch rates. This projects instant success led to the development of a system of anchored buoys which were deployed throughout the offshore waters of the state.

Moored offshore FAD's are also referred to as "tuna buoys" because they capitalize on the behavioral tendencies of certain pelagic fish, like tuna, to aggregate under floating objects. One explanation of such behavior theorizes that small fishes congregate around the floating object for protection and these in turn attract larger predatory species. Another possible explanation is that some pelagic fishes may use the buoys as cleaner stations.

Since the Hawaii project, American Samoa, Palau, the Northern Marianas and Guam have initiated similar offshore FAD programs. Construction of offshore FAD's on Guam began in 1979 as a result of a $20,000 grant from the Pacific Tuna Development Foundation. The project was continued through FY 80 as part of the federally funded Dingell-Johnson Fisheries Development program.

OBJECTIVES

To aggregate commercially important pelagic fishes at point locations accessible to and easy to find by fishermen.

PROCEDURES

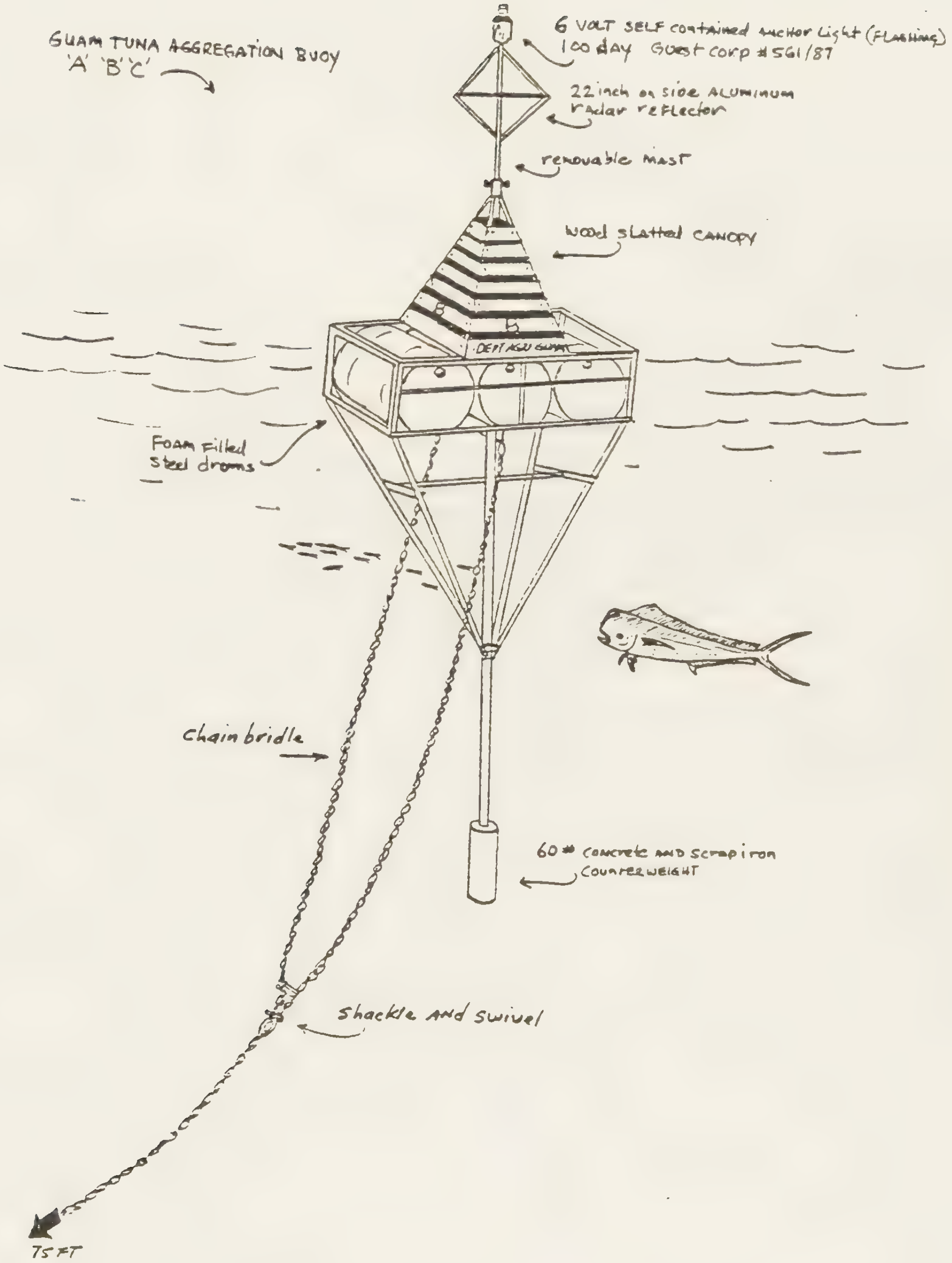
Type I is a raft of three 55 gallon drums filled with foam and held together inside a welded steel frame. The upper exposed portion contains a small tower with a radar reflector and a navigation light. A string of two small, ofam-filled truck tires containing a drapery of discarded netting is attached to the main float for additional surface area (Figure 1). Directly beneath the raft extends a 30 kg concrete counter weight. The mooring system begins with a chain bridle attached to the raft that allows the counter weight to swing. The bridle joins and continues another 18 m down. From the chain 5/8" polypropylene line reaches to the sea bottom where it attaches to another 18 m section of chain. This last section of chain is shackled to a 900 kg cement anchor.

Type II FAD is comprised of one large diamter tire (1.6 meters) utilizing the same ground tackle and navigation configuration as does Type I (Figure 2). Two similar but smaller tires are attached to the main tire. Also attached to the trailing tires is an array of five groups of five floating plastic sono-buoy containers. A modification to Type II FAD employs a lighter, smaller diameter foam filled tire as the main buoy instead of one large tire. Because of buoy losses, which will be discussed later, further modifications to the ground tackle are being contemplated.

Cost of construction and deployment of the Types I and II FAD's are shown in Table I. The approved FAD site locations for Guam's waters are shown in Figure 3.

Table I. Cost of FAD Types used in Guam's Offshore Waters

A.	Type I	
1.	Labor for buoy and mooring line construction	$1,176.00
2.	Materials including foam and anchor	763.00
3.	Polypropylene line (5/8")	800.00
		$2,739.00
B.	Type II (large tire)	
1.	Labor for buoy and mooring line construction	$ 720.00
2.	Materials including foam and anchor	976.00
3.	Polypropylene line (5/8")	800.00
		$2,496.00



GUAM TUNA AGGREGATION BUOY
'A' 'B' 'C'
6 VOLT SELF contained anchor Light (Flashing)
100 day Guest corp #561/87
22 inch on side ALUMINUM
radar reflector
removable mast
wood slatted CANOPY
DEPT AGU GUAM
Foam filled
steel drums
chain bridle
60# concrete and scrap iron
counterweight
shackle and swivel
75 FT

Figure 1. Type I fish aggregating device. The string of two tires mentioned in the text, is shown in Figure 2.

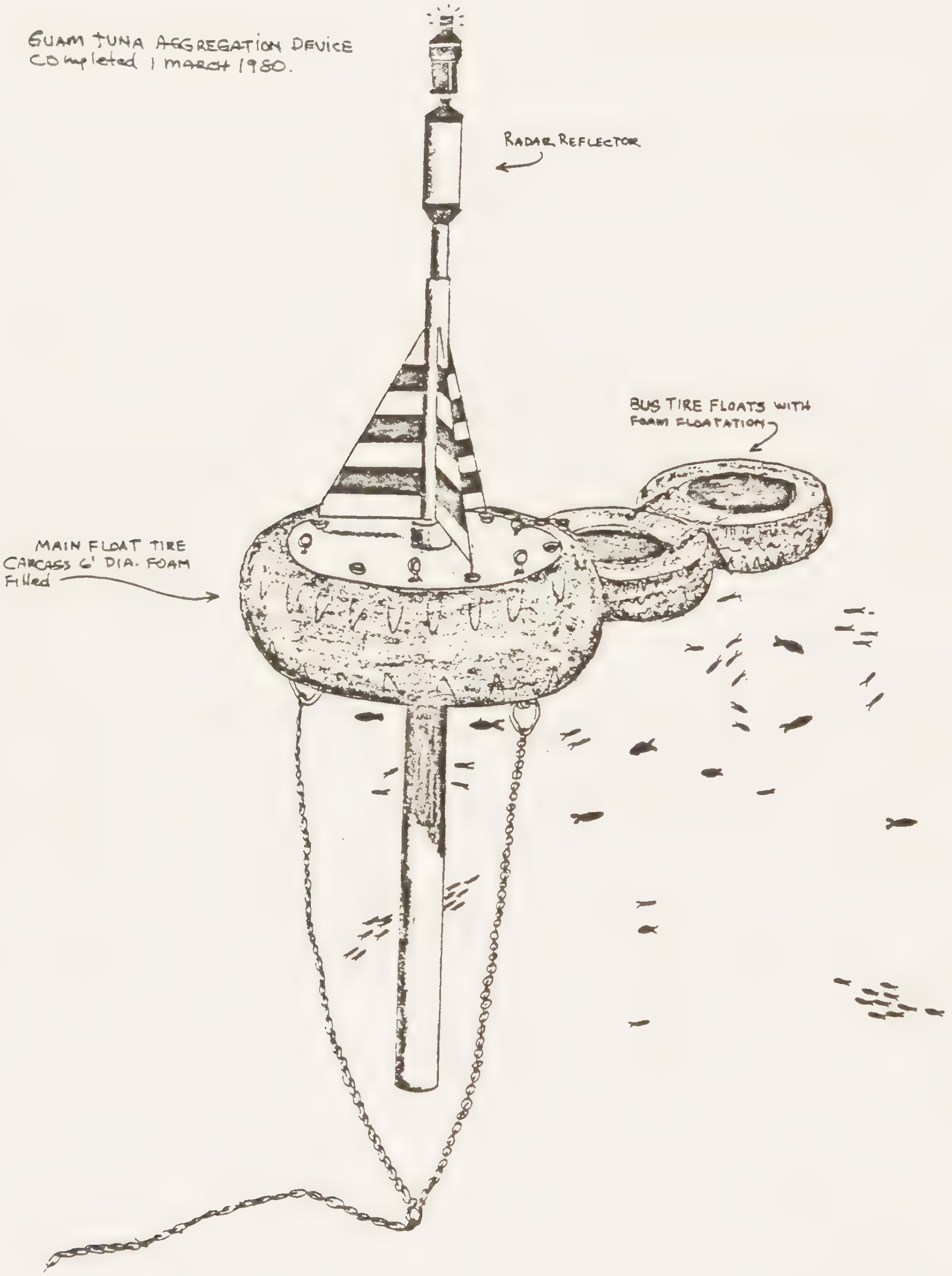
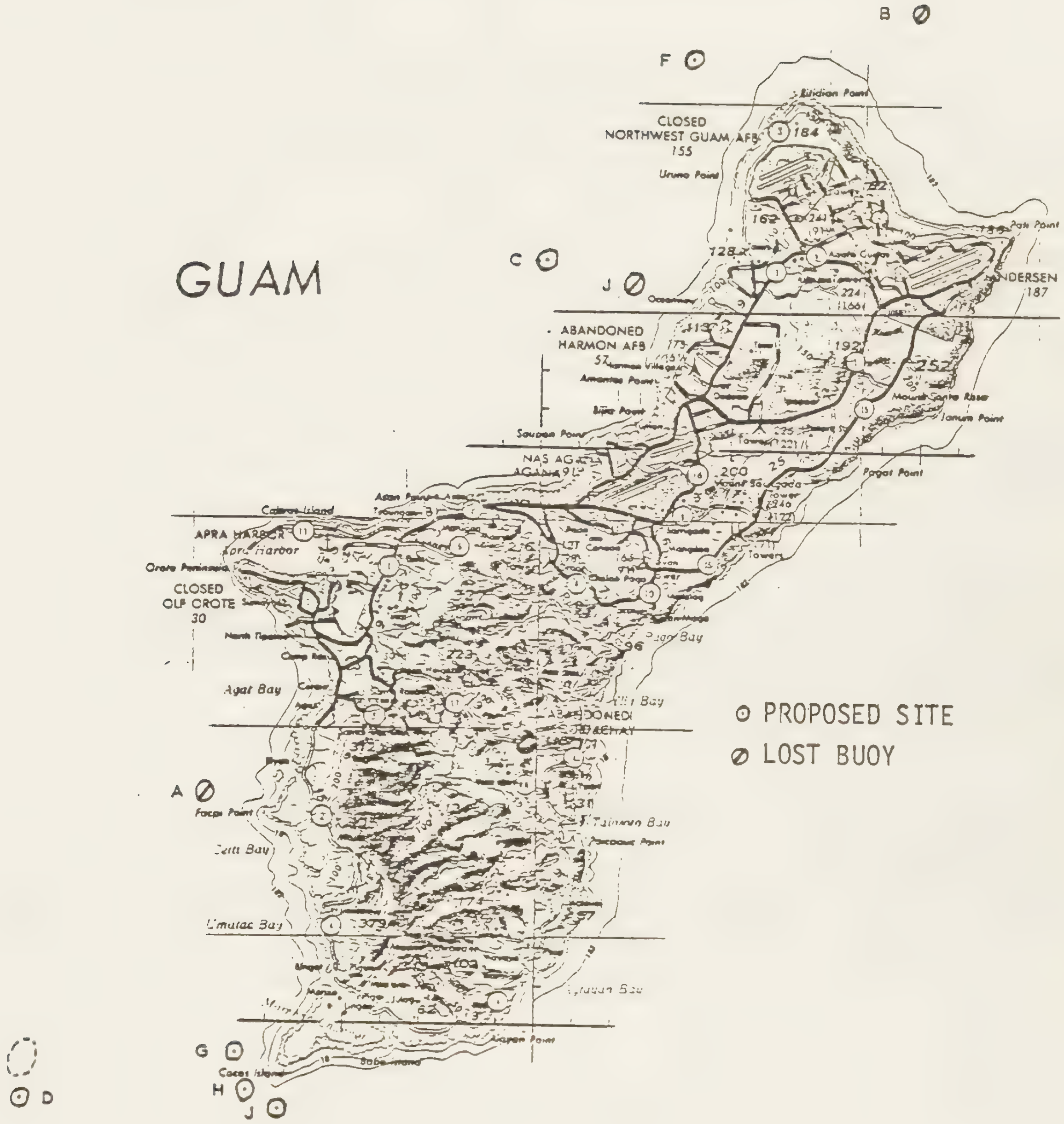

GUAM TUNA AGGREGATION DEVICE
completed 1 MARCH 1980.
RADAR REFLECTOR
BUS TIRE FLOATS WITH FOAM FLOATATION
MAIN FLOAT TIRE CARCASS 6' DIA. FOAM Filled

Figure 2. Type II fish aggregating device shown without the trailing sono buoy-container raft mentioned in the text.



GUAM
B
F
C
J
A
G
H
J
D
CLOSED
NORTHWEST GUAM AFB
155
Ritidian Point
Uruno Point
Pati Point
ANDERSEN
187
ABANDONED
HARMON AFB
57
Amantes Point
Saupan Point
NAS AGANA
Mount Santa Rosa
Janum Point
Pago Point
Cabras Island
APRA HARBOR
Apra Harbor
Orote Peninsula
CLOSED
OLF OROTE
30
Agat Bay
Facpi Point
Cetti Bay
Umatac Bay
Cocos Island
Achang Point
Pago Bay
Talofofo Bay
⊙ PROPOSED SITE
⊘ LOST BUOY

Figure 3. Final approved FAD site locations.

C. Type II (small tire)

1.	Labor for buoy and mooring line construction	$1,200.00
2.	Materials including foam and anchor	870.00
3.	Polypropylene line (3/4", proposed)	1,200.00
		$3,270.00

D. Common Expenses

1.	Transportation to deployment vessel	$ 75.00
2.	Chain	200.00
3.	Deployment	1,000.00
		$1,275.00

Deployment has been a problem and is the main reason for the delays in setting the FAD's. The U. S. Coast Guard buoy tender BASSWOOD deployed the first two Type I FAD's. However, because regular duties brought the ship to Guam for only several days every few months, an alternative vessel was chartered to carry out the deployment. This charter vessel deployed the next two buoys, one Type I and a Type II, FAD, but because this vessel was not equipped with a fathometer, problems were encountered with precise placement which resulted in unsatisfactory performance. Attempts are now being made to locate a more satisfactory deployment vessel.

One maintenance trip was made to the Haputo Point FAD, to change the light and to inspect the chain, shackels and thimbles down to 20 meters. Four trips were made to the Facpi Point buoy. The radar reflector, light and net drapery on this buoy disappeared soon after it was deployed. It is believed the materials were stolen and the decision was made not to replace the expensive navagation light.

FINDINGS

During the past year, three Type I FAD's have been constructed with two having been deployed. There were five Type II FAD's constructed, with one having been deployed (large tire). Because some of the deployed FAD's have broken loose from their moorings, been recovered and redeployed a chronological sequence of events has been prepared and is present in Table 2.

Table 2 Chronological Events Pertaining to Guam FAD's

DATE	LOCATION	ACTION TAKEN	BUOY TYPE
12/8/79	Facpi Point	Deployment	I
12/14/79	Facpi Point	Buoy loss	I
12/14/79	Facpi Point	Buoy retrieved	I
1/3/80	Haputo Point	Deployment	I
4/24/80	Facpi Point	Deployment	II
5/5/80	Haputo Point	Buoy loss	I
6/23/80	North End	Deployment	I
9/13/80	Facpi Point	Buoy loss	II
9/13/80	Facpi Point	Buoy retrieved	II
9/13/80	North End	Buoy loss	I

As can be seen from Table 2, the project has been plagued with the problem of maintaining the FAD's on site. As of this writing there are no functioning FAD's on site. Four buoys have been deployed and all have broken loose; two of those were recovered. The first FAD at Facpi Point was lost when a boat ran over line scope which was floating on the surface. Subsequent mooring lines were constructed to include a midwarp weight to eliminate this problem.

The second FAD that was lost had been placed at Haputo Point. Although this device was not successfully recovered, some local fishermen made an attempt. When questioned, these fishermen reported observing approximately 400 yards of line still attached to the buoy. According to the construction diagram, the break may have occurred at the splice connecting the midwarp weight.

The third lost buoy was the Facpi Point replacement and was retrieved by the Department of Public Safety. According to their personnel, there was no lost on the same day. These and the Haputo Point FAD's were lost during periods of unusually severe storm activity.

Two methods have been used to assess the effectiveness of the FAD's on Guam. The most useful method has been through fisherman interviews which were incorporated into our regular creel census process. The other method is to dive with SCUBA and to make a visual assessment of the species present.

The fishermen interviews are carried out during regularly scheduled creel census days and the fishermen are queried as to their catches around the FAD's. The results of these interviews indicated that an estimated 120 fishing visits were made to the Haputo FAD during February and 28 percent successfully caught fish. Mahi mahi (Coryphaena hippurus), averaging about 4 kgs, comprised most of the catch which also included a few wahoo (Acanthocybium solandri). The total catch of fish from the FAD's was estimated to be between 500 to 700 kgs. Most of the fish were caught in the early morning or evening with no catches reported between 1000 and 1700 hours. During March an estimated 60 visits were made to the Haputo Point FAD which amounted to about 60% of the total fishing trips made out of Agana Boat Basin in that month. Approximately 20% of the boats that fished the device caught fish. A monthly estimate of 116 kg of mahi mahi were caught within about one half mile of the buoy. These fish averaged around 3.8 kg each. No other species were recorded. All catches were made before 1100 hrs and after 1430 hrs.

Information gathered on the North End buoy was less detailed because it was not fished as regularly. Also, it was considerably further away from the Agana Boat Basin than was the Haputo Point buoy, and was located in the rough water between Rota banks and northern Guam. Although the catches were not large or consistant, they were frequent enough to make fishermen use it when the seas permitted. Catches consisted mostly of wahoo and skipjack. Oceanic grey sharks were also caught.

The few reports received regarding the Facpi Point buoy suggest that this buoy could be the best one if it were not for the shark problems. One local fisherman caught fish on seven visits. Better catches were in the morning, and included skipjack, mahimahi, rainbow runner (Elegatis bipinnulatus) and yellow fin (Thunnus albacares). The yellowfin were large (>18 kg) but none were landed whole without shark bites.

Buoy assessments were made during maintenance dives and were usually reported as general observations with no quantifications. Only one trip was made to the Haputo Point FAD but during that dive approximately 20 trigger fish (Canthidermis maculatus) and one small pilot fish were observed.

Four dive trips were made to the Facpi FAD where wahoo, rainbow runner and mahi mahi were observed. It also appeared that the species which actually utilized the buoy proper, inhabited spacially stratified depths under the FAD. Juvenile filefish (Cantherhines pardalis) and rudder fish (Kyphosus sp) were distributed within the first two meters of depth. Adult Canthidermis maculatus, juvenile nomeids (Psenes cyanophrys) and juvenile jacks (Carangoides sp) were distributed to a depth of 15 meters. Below 15 meters there was a large (estimated in thousands) school of opelu or mackerel scad (Decapterus sp) and two grey reef sharks (Carcharhinus amblyrhynchos).

RECOMMENDATIONS

I. In order to achieve a greater success in retaining FAD's on the established sites, a more suitable ground tackle system needs to be developed. Before additional FAD's are deployed it is recommended that shallow water studies, possibly using a smaller FAD of similar design, be conducted. This would involve anchoring the device in water at a maximum depth of 35 meters and periodically conducting SCUBA observations on the lines and bridles and determining exactly where the breakaway problems are occuring.

II. Once FAD's are deployed, routine inspection and reviewing should be carried out on a monthly basis. During the inspection, underwater visual observations on the aggregation of fish around the buoy should be made and if possible, several hours of shallow and deep trolling be undertaken for species which may not be observed during the diving. Continued use of creel census queries will further expand the data base.

TROLLING LANES

Summary

A midwater attracting device was designed to be used in the construction of trolling lanes. Twenty-nine devices were constructed during FY 80 and an Army Corps of Engineers permit was applied for to deploy these devices in Agat Bay and Tumon Bay. The permit was granted and nine devices were deployed together as one trolling lane in Agat Bay.

No fishing has been conducted in the vicinity of this trolling lane but several visual observations were made using SCUBA. Storm activity caused some of the units to break up and others to become twisted together. It is still too early to evaluate the effectiveness of a trolling lane but visual observations are encouraging.

Background

Like fish aggregating devices, midwater attracting devices also take advantage of the behaviorial tendencies of certain pelagic fishes to congregate around objects in the sea. Unlike fish aggregating devices, midwater attracting devices are stationed close to shore in shallow water (50 m or less), and they do not break the surface. Midwater attracting devices consist of clusters of plastic cylinders attached at roughly 6 m intervals along a piece of line. The line is anchored to the bottom and extends upward approximately 2/3 of the distance to the surface. Several of these devices are deployed in a line that may run a quarter mile or more. A run of such devices will be referred to as a trolling lane.

The potential application of midwater attracting devices to improve pelagic sport fish catches, was suggested by Wickham and Russell (Wickham 1973) based on observations obtained while evaluating the use of midwater attracting structures for coastal pelagic bait fishes such as sardines and herring. Since this study, trolling lanes have been constructed in Florida and South Carolina. However, no studies have been attempted on a tropical island such as Guam. Since midwater attracting devices have been effective elsewhere and are so inexpensive to make, Aquatic & Wildlife Resources decided to investigate their potential for Guam. If successful, trolling lanes may serve to bring pelagic fish closer to shore where small boat fishermen could save time and fuel searching for fish.

Objectives

To attract pelagic fishes closer to shore at point locations accessible to small boat fishermen.

Procedures

The midwater attracting structures currently used on Guam are made from buoyant surplus sono-buoy packaging cylinders, which are one meter in length and .15 meters in diameter. The tackle consists of odd lengths of polypropylene line, fishing line, a small rebar grappel and gravel-filled sinkers (Figure 4). The approximate cost of a typical module consisting of five clusters (each cluster comprised of five cylinders) is approximately $23.00 (Table 3).

The deployment procedure begins with situating marker floats at either end of the proposed lane. The work boat then runs along the line between the marker floats and throws off the sinkers and rebar anchors. The attached midwater structure follows. Units are placed approximately 20 meters apart and extend to within 7 meters of the surface (Figure 4). Nine units were deployed in the vicinity of the artificial reef (ARAB) in Agat Bay.

Findings

As yet, fishing on these trolling lanes has not been attempted but three dives were made to inspect the anchoring systems and to see if fish were present.

The first unit was deployed in May 1980 in Agat Bay at a site approved by the Army Corps of Engineers. An inspection dive made a month later showed

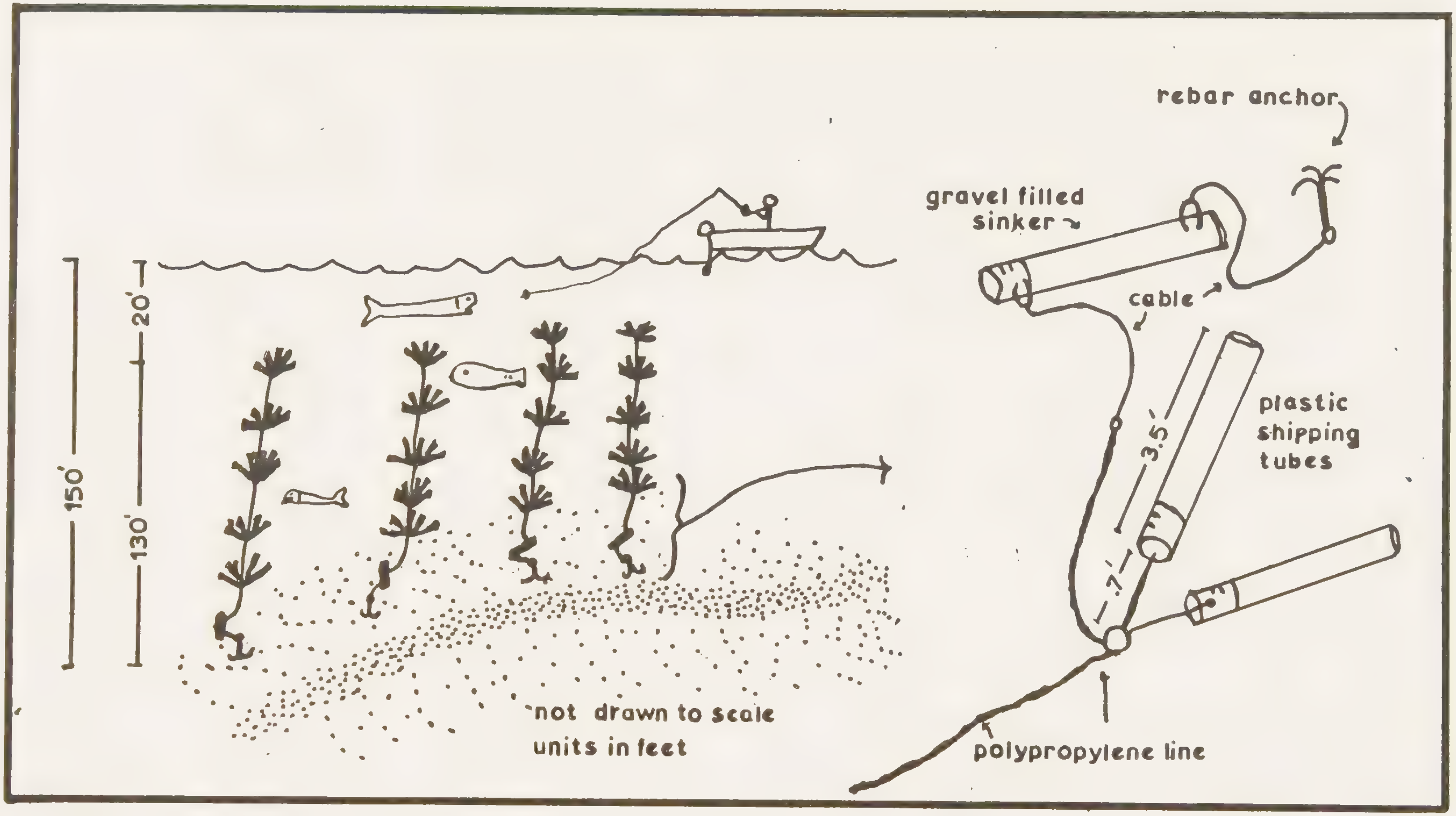

150'
20'
130'
rebar anchor
gravel filled sinker
cable
cable
plastic shipping tubes
3.5'
.7'
polypropylene line
not drawn to scale
units in feet

Figure 4 Trolling Lane showing design of midwater attracting structures, the anchoring system and installation.

Table 3. Material Costs for a Single Midwater Device, 38 m High and Suitable for Deployment in 45 m.

MATERIALS	SOURCE	COST
25 Sono-buoy packaging cylinders	Naval Surplus	$ 12.50
Rebar grapped anchor	Welding Shop	8.50
100' of 1/8" polypropylene line	FAD Left-over	on hand
Clothing line plastic coasted cable	Retail Store	.70
4 Wire clips	Retail Store	1.20
		$ 22.90/uni

The structure still intact, so eight more units were deployed in early July. These were inspected once again in August before a September storm (the same storm that carried two tuna buoys away) rearranged the alignment of thedevices. Four broke away and the others were twisted together.

During these dives we noted that it took about two months for an agal covering to develop on the cylinders. It was found to be more abundant on the shallower groups of tubes. As soon as this covering developed, a damsel fish species (Abudefdug sexfaciatus) and an unidentified carangid species began to reside about the cylinders. More individuals were observed around the shallower cylinders than near the mid-water or bottom cylinders. A school of approximately 40 rainbow runner were observed around the devices during the 30 minute dive made in August. The same damsel fish individuals seemed to be present on the tubes even after the September storm.

RECOMMENDATIONS

It is too early to evaluate the effectiveness of these devices, but so far the results are encouraging. Twenty more units have been constructed and it is recommended that preparations made to deploy them in a cluster on one of two 50 m transects of a depth of 100 ft. near Ipao Point. Fish counts have been conducted on these transects for over a year and will provide a good data base. The other 50 meter transect at that depth will be used as a control.

REFERENCES CITED

Wickham, D. 1972. Development of mid-water reefs. Proc. Sport Fishing Seminar, November 1971, Jekyll Island, GA. Seminar Series No. 1:7-10.

Report prepared by R. Logan Kock

Biologist conducting fish count under aggregating device.

JOB PROGRESS REPORT
FISHERIES DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D-2
SUB-PROJECT NO.: FD-2b

JOB TITLE: Construction of Artificial Reefs

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

The Division of Aquatic and Wildlife Resources participated in selecting a site for the disposal of a large steel ship for use as an artificial reef. The Navy successfully removed the abandoned vessel from a reef in Apra Harbor but was unable to sink it at the proposed site. The location of the vessel is unknown.

BACKGROUND

Involvement with artificial reefs by Aquatic & Wildlife Resources (AWR) began on Guam in 1970 with the construction of a low profile tire reef in Cocos Lagoon. A second tire reef, higher in profile, was completed in 1973, approximately 200 meters from the low profile reef (DAWR Annual Report FY 1978). Biologists who studied the reefs for five years determined that the higher profile reef attracted a greater number and a higher diversity of fish than the low profile design. They also determined that rubber is not the best material for coral planula settlement. This lack of coral recruitment may explain why these artificial reefs did not contribute significantly to the general fish biomass of the area. Live coral patches half their size at adjacent areas had more fish. Coral and fish recruitment may have been improved if these reefs were located in a shallower area or where siltation is less. It appears that the tire reefs, which are located in the deepest part of the lagoon (6 to 10 m) are either sinking or being buried by silt. The low profile reef was only half exposed by 1979.

Considering the above information and the incredible fish recruitment observed on the underwater wrecks in Truck Lagoon, WCI, we decided to use an available 18 m long steel LCM barge as our next artificial reef in 1976. Two years of research on this reef determined that a steel ship will stay in place on the outer reef slope where the water is clear and siltation is less. Also, steel was found to be an excellent substrate for coral recruitment and growth, which led to an increase in the diversity of habitat and fish biomass.

Forage fish recruitment to the barge was determined to be seasonal (AWR Annual Report FY 1979). Comparative studies on surrounding reef areas led to the development of several hypotheses that will contribute to future reef designs. For example, in order to attract and keep big fish at a point location (such as an artificial reef) it is important to maintain an abundant food resource that will contrast with surrounding areas as well as provide large habitat areas. This can be accomplished by constructing artificial reefs with greater emphasis on providing abundant habitat for small forage fish rather than just for large fish.

With the information generated from the LCM reef it is possible to design an effective offshore, reef slope, artificial reef. Limited funds, however, preclude this effort, and lower-cost alternatives have thus far been unsuccessful. In 1978 Aquatic & Wildlife Resources was contacted to select an underwater site for the recycling of one of two ships which had run aground in Apra Harbor during Typhoon Pamela in 1976. The Army Corp of Engineers together with the Navy and Coast Guard removed the M/V Peace Ocean, a rusting 77 m fuel tanker in August 1979. Although the proposed artificial reef site was only 10 miles south of the harbor, problems keeping the vessel afloat necessitated sinking it approximately 10 miles straight out to sea.

OBJECTIVES

To provide for the construction and deployment of artificial reefs in order to enhance the quality of recreational fishing through increased landings and higher CPUE values.

PROCEDURES

The proposed artificial reef site was selected during the previous report period for the disposal of another steel ship, the M/V Slidre.

RESULTS

The M/V Slidre, the second grounded ship in Apra Harbor, became available for use as an artificial reef during FY 80. The same FY 79 site was recommended and approved for the recycling of this ship. It required nearly a week to remove the Slidre from the reef but it came off intact and floating. The proposed site was bracketed with fluorescent painted buoys and the ship was towed to the site. Unfortunately, for some classified reason the Slidre was sunk about a mile offshore of the proposed site to a depth of over 100 fathoms. Presently, there are no suitable ships available for use as artificial reefs, and except for the attempt to use the Slidre this project was inactive this year.

RECOMMENDATIONS

Damaged cement conduits and cement rubble should be placed in high piles around and in the LCM artificial reef. This should increase its habitat diversity and provide additional living space for small fishes especially.

Report prepared by R. Logan Kock

SECTION IV

Aquaculture
(Public Law 88-309 Matching Funds)

Project Title: Development of Tropical Polyculture Fish Farming

Period Covered: October 1, 1979 through September 30, 1980

Funding Source: National Marine Fisheries Service (Public Law 88-309)
Government of Guam

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. PLATFORM FERTILIZATION WITH TRIPLE PHOSPHATE AT NAVY FUEL DEPOT POND

. THE EFFECTS OF DIFFERENT FOODS ON HYBRID TILAPIA PRODUCTION

. FRESHWATER PRAWN, *MACROBRACHIUM ROSENBERGII*, DEMONSTRATION PROJECT

. LITERATURE CITED

SUMMARY

The Division of Aquatic and Wildlife Resources continued work with the development of aquaculture on Guam during FY 80. Technical assistance and information was provided to people involved in aquaculture; and comments were prepared on a GEDA loan for construction of a freshwater prawn project at Talofofo, and an aquaculture loan program for the Department of Commerce. Field projects were conducted on the freshwater prawn, *Macrobrachium rosenbergii*, hybrid tilapia (*Sarotheradon mossambica* x *S. nilotica*), the water quality of selected rivers with aquaculture potential and pond fertilization. Due to Tropical Storm Tip in October, 1979, the existing fish rearing facility had to be repaired. Initial steps were taken to construct a fish rearing facility for the Thai catfish, *Pangasius sutchi*, at the Department of Agriculture.

EXTENSION PROGRAM

The extension program of the Department of Agriculture provided services to individuals in the existing aquaculture industry (Table 1) as well as people interested in aquaculture development (Table 2). Regular, routine visits were found to provide the best assistance, and allow for an exchange of ideas and technical information on a one-to-one basis. Occassionally, people visited the office and discussed aquaculture development. If a visit to the prospective aquaculture site was desired, we would evaluate the area and make recommendations on site feasibility.

Our work with freshwater prawns, *Macrobrachium rosenbergii*, accounted for a major portion of our extension effort. Due to Tropical Storm Tip which occurred in October, 1979, the Government of Guam allocated $20,000 for prawn shipments to qualified aquaculturists. The first shipment of 202,400 post-larvae arrived on November 6, 1979 and was divided between two aquaculturists. On May 1, 1980, the second shipment of 202,400 post-larvae were distributed to six aquaculturists (Table 3). Physical, biological, and chemical parameters were collected on most routine visits and the prawns were sampled every four weeks to compute feeding rates. At harvest time, data were collected for later analysis.

Recently, the University of Guam Extension Service hired an aquaculture extension worker and our extension program has been turned over to him. More emphasis will now be placed on research and fish production, especially the Thai catfish, *Pangasius sutchi*, and hybrid tilapia (*Sarotheradon mossambica* X *S. nilotica*).

Aquaculture Association

In visiting with people involved or interested in the aquaculture industry, it became apparent that an organization was needed to solve and discuss a variety of common problems and concerns. The following list summarizes these problems.

1. There is a lack of interaction and exchange of ideas between interested parties.

2. The industry is fragmented and unorganized. Potential aquaculturists need information regarding the necessary government permits, clearances, and steps required to initiate an aquaculture operation, prime land available for development, information on available loans, a general description of our aquaculture industry, and marketing potential here and abroad.

Table 1. Major Commercial Aquaculture Ventures on Guam

NAME & ADDRESS	LOCATION	PHONE
Eels		
Peter Wang - President Guam Marine Products, Inc. 142 W Seaton Agana, Guam 96910	Inarajan	472-6715 477-7435
Tilapia		
Joe Perez - Manager Perez Bros, Inc. Marine Drive Agana, Guam 96910	Mangilao	472-6861 472-6862 472-6863
Prawns		
Joe Baza - Manager Merizo, Guam 96910	Merizo	828-8224
Tropical Agriculture Development Corp. P.O. Box 7948 Tamuning, Guam 96911	Talofofo	477-7330
Joe Roberto Sinajana, Guam 96910	Talofofo	472-8452
Fred Mendiola Talofofo, Guam 96914	Talofofo	789-1692
Miguel T. Quitugua Talofofo, Guam 96914	Talofofo	-
Alfred Flores Malojloj, Guam 96916	Inarajan	828-8507
Jerry McDonald Fonte, Guam 96910	Fonte	-

Table 2. List of People Given Technical Aquaculture Assistance From October 1, 1979 to September 30, 1980.

NAME	LOCATION	COMPANY	INTEREST
Mr. Joe Baza	Merizo	Private	Prawn
Mr. John Bernardo	Naval Station	Private	Tilapia
Mr. Bob Bevacqua	Talofofo	Private	General
Mr. Frank Cabrera	Piti	Private	Prawns & Tilapia
Mr. Bob Camp	Maite	Private	Backyard Pond
Mr. Tom Campion	Agat	The Ark	General
Mr. Bob Carson	Yona	Private	Brine Shrimp
Mr. Leonard Chang	Talofofo	Trop. Agr. Dev. Corp.	Prawns
Mr. Ben Dela Rosa	Agana	Private	General
Mr. Dom DoDong	Dededo	Private	Backyard Pond
Mr. Endo	Tamuning	Tokai Pacific Company	Shrimp & Eels
Mrs. Ruth Erskine	Tamuning	Calvo Management	General
Mr. Hugh Fawcett	Merizo	Private	Marine
Mr. Tom Garrido	Agana Heights	Private	Prawns & Tilapia
Mrs. Kim Hebert	Yigo	Private	Tilapia
Mr. Tim Hebert	Yigo	Private	Tilapia
Mr. Greg Hulbrook	Windward Hills	Windward Hills Golf Country Club	Prawn
Mr. Hwang	Talofofo	Trop. Agr. Dev. Corp.	Prawn
Mr. Hiromi Kawamura	Japan	Suzue Guam Co. Ltd.	Tilapia
Mr. Jerry McDonald	Fonte	Private	Prawn
Mr. John McNeil	Yigo	Private	Prawns & Tilapia
Mr. Fred Mendiola	Talofofo	Private	Prawn
Mr. Ralph Mesa	Dededo	PUAG	Technical Assistance

Table 2. Continued

NAME	LOCATION	COMPANY	INTEREST
Mr. Jesus Naputi	Inarajan	Private	Prawn
Mr. Edward Peredo	Sinajana	Private	Prawn
Mr. G.G. Perez	Yigo	Private	Prawn
Mr. Joe Perez	Mangilao	Perez Bros. Inc.	Tilapia
Mr. Don Price	Apra Heights	Private	Tilapia
Mr. Felix Quan	Agana	Guam Farmers Coop. Assn.	General
Mr. Mike Quitugua	Talofofo	Private	Prawn
Mr. Florencio Ramirez	Ordot	Private	Prawn
Mrs. F. Reese	Yigo	Private	General
Mr. Joe Roberto	Talofofo	Private	Prawn
Mr. Ben Sanchez	Umatac	Private	Aquarium
Mr. Jose Sanoma	Inarajan	Private	Prawns & Tilapia
Mr. Lawrence Ting	Taipai, Taiwan	Private	Shrimp
Mr. Carl Villagomez	Barrigada Heights	Private	General
Mr. Peter Wang	Inarajan	Guam Marine Prod. Inc.	Eel

Table 3. Distribution of Two Freshwater Prawn, *Macrobrachium rosenbergii*, Shipments

November 7, 1979

Name	Total No. Post Larvae	Sq. Meters	No/M^2
Mr. Joe Baza Merizo, Guam 96916	101,200	3,276	30.89
Tropical Agriculture Development Corp. P.O. Box 7948 Tamuning, Guam 96911	101,200	2,596	38.98

May 1, 1980

Name	Total No. Post Larvae	Sq. Meters	No/M^2
Mr. J.J. Perez Cement Tank	2,200	51.84	42.4
Mr. Joe Baza Earthen Pond	39,600	2115.94	18.7
Mr. Mike Quitugua Earthen Pond	35,200	2223.0	15.8
Mr. Joe Perez			
Cement Tank 1	4,400	90.65	48.6
Cement Tank 2	2,200	80.40	27.4
Cement Tank 3	4,400	88.8	49.6
Mr. Fred Mendiola Mr. Joe Roberto			
Earthen Pond 1	57,200	2432	23.5
Earthen Pond 2	22,000	945	23.3
Earthen Pond 3	35,200	1554	22.7

3. Obtaining supplies and equipment from off-island at a low cost has been difficult. It has been suggested that an aquaculture group have an affiliate membership with the Guam Farmer's Cooperative Association, without profit-sharing obligations, to get discounts in purchasing supplies and equipment.

4. Because of the unavailability of local persons with aquaculture skills, pond owners tend to prefer foreign laborers who possess these skills, however immigration laws restrict importation of foreign laborers.

5. Coordinated efforts are needed to promote quality control and marketing of aquaculture products.

6. A need for freezer and cold storage facilities. The industry could perhaps cooperate with existing fisheries and agricultural cooperatives to construct a facility.

7. There has been a constant concern for the government multipurpose hatchery that has been proposed for a number of years. The hatchery has been a high priority of the government; but until now, no action has taken place. Perhaps, a unified voice to the government leaders from the private sector would help.

For these reasons, the numerous pond owners were encouraged to form an aquaculture association on Guam to strengthen the industry. The Department of Agriculture played a lead role in forming this organization. The Cooperative Extension Service staff at the University of Guam assisted in drafting the by-laws and articles for the Guam Aquaculture Association. The address for the organization is the Guam Department of Agriculture, P.O. Box 2950, Agana, Guam 96910. The association meets regularly on the first Monday of each month. President, Vice-President, and Secretary-Treasurer were elected from the local aquaculture industry.

WATER QUALITY EXAMINATION OF INARAJAN AND TALOFOFO RIVERS

SUMMARY

Baseline, water quality data were collected for the Inarajan and Talofofo Rivers. The Talofofo River was found to have chloride levels which could affect the selection of species to be cultured, and other low-lying rivers on Guam may exhibit similar chloride levels. The waters of the Inarajan River appear to be suitable for aquaculture use.

BACKGROUND

An important requirement for successful aquaculture is a reliable source of high quality, freshwater. On Guam, the major rivers with aquaculture potential are in the southern portion of the island. However, water quality information is needed to determine the suitability of these rivers as aquaculture water sources.

OBJECTIVE

I. To determine the physical and chemical water quality of the Talofofo and Inarajan Rivers, and evaluate these rivers as water sources for aquaculture.

PROCEDURES

Two sampling sites were selected for each river. Downstream samples were taken near the mouth and upstream samples taken approximately two kilometers above the downstream site. Samples were collected in May, July, September and December, 1979, so that seasonal differences might be apparent.

Surface, water samples were collected with a plastic pail. Temperature, specific conductance, and pH were measured in the field. All other chemical and physical water analyses were performed at the Water Resources Research Center of the University of Guam. Standard methods of analyses were used (American Public Health Association, 1975; Strickland and Parsons, 1968; U.S. Dept. Interior, 1969).

RESULTS

Tables 1 and 2 present the water quality data for the Talofofo and Inarajan Rivers, respectively. Little seasonal variation in water quality was apparent. In September however, the turbidity and suspended solids increased markedly, while chloride levels dropped for both rivers. Prior to the September sampling, several days of rain occurred and this undoubtedly influenced the data.

Higher values for total dissolved solids and chloride occurred at the lower stations than at the upper stations, for both rivers. The differences reflect the influence of the salt water intrusion on the lower reaches of

Table 1. Water Analysis Data for the Talofofo River, Talofofo, Guam

Parameter	May 15, 1979 Site Upper	May 15, 1979 Site Lower	July 12, 1979 Site Upper	July 12, 1979 Site Lower	September 16, 1979 Site Upper	September 16, 1979 Site Lower	December 27, 1979 Site Upper	December 27, 1979 Site Lower
PHYSICAL								
Temp., ^{o}C	29.0	29.5	29.7	30.3	26.1	27.8	26.3	26.7
Turb., NTU	4.0	3.5	0.8	1.3	35.0	55.0	4.7	4.5
Sp.-Cond., umho/cm	1450	3000	2600	6500	255	320	1300	2600
Settleable, ml/l	-	-	-	-	-	-	<1	<1
TS, mg/l	1200	2000	1616	3984	192	224	1888	2056
SS, mg/l	3.8	3.8	4.8	7.6	23.8	38.7	1.0	5.8
TDS, mg/l	1196.2	1996.2	1611.0	3976.0	168.2	185.3	1887.0	2050.2
CHEMICAL								
pH	6.60	6.80	6.25	6.50	7.33	7.15	7.81	7.53
Total Alk, mg/l	91.2	118.5	89.0	106.0	97.0	87.0	223.0	235.0
Phen. Alk, mg/l	00.0	00.0	00.0	00.0	00.0	00.0	0.00	0.00
Chloride, mg/l	976	1540	722	1946	28	50	294	732
D.O., mg/l	4.28	4.79	3.60	5.27	6.11	5.69	6.62	5.98
BOD, mg/l	.97	2.17	.90	1.80	1.50	1.40	3.22	>7.60
TKN, mg/l	.624	.062	.100	.200	.150	.470	<.010	.013
NH_4-N, mg/l	<1ppm	<1ppm	.400	.350	.030	.030	.005	.013
NO_2-N, mg/l	<.001	<.001	.002	.003	.016	.002	<.001	<.001
NO_3-N, mg/l	.222	.174	.006	.013	.027	.056	.005	<.001
T-P, mg/l	.026	.018	.010	.014	.010	.008	.027	.020
REA-P, mg/l	.020	.010	.006	.003	.008	<.001	.004	.001
Calcium Hardness, mg/l	89.0	127.0	94.2	184.0	75.6	67.7	198.0	352.0
Hardness, mg/l	232.8	334.0	298.0	704.8	101.5	105.5	92.0	155.0

Table 2. Water Analysis Data for the Inarajan River, Inarajan, Guam

Parameter	May 15, 1979		July 12, 1979		September 16, 1979		December 27, 1979	
	Site		Site		Site		Site	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
				PHYSICAL				
Temp., ^{o}C	27	29.8	27.5	30.4	28.3	27.8	25.2	25.8
Turb., NTU	17.5	25.5	2.8	5.7	37.0	37.0	3.8	4.2
Sp.-Cond., umho/cm	180	1200	200	1800	132	540	170	540
Settleable, ml/l	-	-	-	-	-	-	<1	<1
TS, mg/l	188	800	252	1208	148	332	240	412
SS, mg/l	13.3	20.0	7.0	10.6	8.6	14.2	1.0	8.4
TDS, mg/l	174.7	780.0	245.0	1197.0	139.4	317.8	239.0	403.6
				CHEMICAL				
pH	6.79	6.50	6.30	6.40	7.22	7.12	7.45	7.49
Total Alk., mg/l	56	53	76	78	52	51	102	106
Phen. Alk., mg/l	00.0	00.0	00.0	0.00	0.00	0.00	00.0	00.0
Chloride, mg/l	33	650	16	506	15	133	57	130
D.O., mg/l	6.38	6.30	6.32	7.30	7.12	7.08	7.71	7.60
BOD, mg/l	0.60	0.50	0.50	2.20	1.10	0.20	2.27	1.05
TKN, mg/l	0.182	0.697	0.150	0.390	2.170	0.370	0.044	0.035
NH_4-N, mg/l	<1ppm	<1ppm	.100	<.010	.040	.040	.004	.012
NO_2-N, mg/l	<.001	<.001	.002	.002	.001	.000	<.001	<.001
NO_3-N, mg/l	.158	.158	.007	.005	.014	.012	.001	<.001
T-P, mg/l	.041	.060	.014	.014	.013	.005	.311	.027
REA-P, mg/l	.010	.020	.010	.009	.012	.008	.014	.011
Calcium Hardness, mg/l	30.8	48.1	32.0	62.0	17.9	25.9	58.1	80.4
Hardness, mg/l	53.0	148.8	66.8	220.0	39.8	81.6	28.0	44.0

the rivers. The Talofofo River was especially influenced by the salt water because it's low gradient permits the intrusion to advance further upstream. The resultant, chloride levels could restrict the selection of organisms to ones which can tolerate fresh and slightly brackish water. If the organisms cultured are completely dependant on freshwater, an alternative source of water would have to be located. Other, low-lying rivers may have similar salinity fluctuations. Nitrogen, phosphorus and B.O.D. parameters, which are indicators of nutrient enrichment, were low for both rivers. All of the parameter values fell within expected ranges and none would prevent the use of the Talofofo or Inarajan Rivers for aquaculture.

RECOMMENDATIONS

As water quality varies with rainfall and tidal intrusion, potential sources of water for aquaculture should be examined frequently throughout a yearly period, to ascertain the range of chemical and physical parameters.

PLATFORM FERTILIZATION WITH TRIPLE PHOSPHATE AT NAVY DEPOT POND

SUMMARY

The U.S. Navy Fuel Depot pond was fertilized with triple phosphate using a platform at mid-water level. The phytoplankton levels increased after each addition of fertilizer.

BACKGROUND

Pond productivity can be increased by adding inorganic fertilizer. Fertilization induces phytoplankton growth, which provides food for zooplankton and fish. If adequate levels of phytoplankton are maintained to provide natural food for fish, supplemental feeding can be reduced.

OBJECTIVE

I. To increase phytoplankton growth with inorganic fertilization.

PROCEDURE

The U.S. Navy Fuel Depot pond is stocked with the local tilapia (*Sarotherodon mossambica*), hybrid tilapia (*Sarotherodon mossambica* x *S. nilotica*), Thai catfish (*Pangasius sutchi*), grass carp (*Ctenophyngodon idellus*), big head carp (*Aristichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*). It is rectangular in shape, (35.5m by 27.8m) and covers approximately 986.9m^2. The bottom consists primarily of clay, and water depth averages 1.2m. Water is gravity fed to the pond through a pipeline from the adjacent Sasa River. During this study, water was added only to maintain the water level in the pond.

Phytoplankton levels in the pond were estimated visually with a secchi disk. If the visibility of the water was greater than 40 cm, four kilograms of triple phosphate (46%) fertilizer were weighed and placed on a table, at mid-water level. Phytoplankton levels were again checked within 1-2 days of each fertilization. Visibility, pH, total hardness, and temperature were measured on seven occasions with the secchi disk, comparator, water-chex water test units and thermometer respectively (Table 1).

RESULTS

Application of fertilizer was required three times during the 30 day study, to maintain phytoplankton levels. After each addition, visibility decreased about 20 cm and the bloom lasted approximately 10 days.

Water hardness and pH were not significantly influenced by the addition of fertilizer or the increased phytoplankton levels.

RECOMMENDATION

Growth rate studies should be conducted on the fish in the pond, to determine the effect of increased phytoplankton levels.

Table 1. Physical and Chemical Parameters from Navy Fuel Depot Pond

DATE	pH	HARDNESS (mg/l)	TEMPERATURE °C AIR	TEMPERATURE °C WATER	VISIBILITY (cm)
11-19-79	7.9	300	30.5	34.0	*56
11-21-79	7.9	300	30.5	32.5	45
11-29-79	7.7	300	29.0	32.5	*70
11-30-79	8.1	400	27.0	33.5	35
12-5-79	8.1	300	27.0	32.0	35
12-18-79	7.9	400	29.0	31.5	*55
12-19-79	8.1	400	28.5	30.0	45
MEAN	8.0	342.9	28.8	32.3	49

*Date fertilization occurred with triple phosphate, 46% fertilizer on platform at mid-water depth.

THE EFFECTS OF DIFFERENT FOODS ON HYBRID TILAPIA PRODUCTION

SUMMARY

The performance and yields of two types of foods a specially formulated tilapia food of 28% protein, and whole oats, were tested during a hybrid tilapia production trial. The fish fed the specially formulated food exhibited growth rates approximately four times greater than those fed whole oats.

BACKGROUND

Several foods are available locally and abroad for tilapia production on Guam. A specially formulated, tilapia food (23% protein) and whole oats can be imported from Taiwan. A local fish food (28% protein) is presently being used for tilapia culture by commerical operations on Guam. Production data on these foods are lacking.

OBJECTIVE

I. To evaluate the performance and yields of three foods for hybrid tilapia production on Guam.

PROCEDURE

Two, plastic-lined, aluminum swimming pools, with diameters of 7.2 meters, depths of 1.2 m and volumes of 48,430 liters (12,795 gal.) were used. Each pool had inflow and outflow pipes for water level manipulation and drainage. Periodically, water was added to the pools to maintain proper water quality. Two types of fish foods were used: 1) whole oats from Taiwan and 2) hybrid tilapia feed (23% protein), manufactured by President Enterprises, Inc., Taiwan.

A third treatment, using the local food (28% protein), manufactured by Hunt and Behrens, Inc., Guam, was included to compare the production of the local food to the imported foods. The treatment was destroyed on December 12, 1979, when the metal siding ruptured and the plastic lining was destroyed. Only one month of data was collected before the treatment terminated however, the tilapia were showing growth rates comparable to those of the other two treatments.

One thousand hybrid tilapia (Sarotherodon mossambica X S. nilotica), each approximately 11 cm in length, were stocked in each pool. Tilapia with the black-green color phase accounted for 95% of the fish, and the remainder exhibited the orange-red color phase. At about two week intervals, fifty tilapia were randomly sampled from each pool for total length and weight measurements. Total weight of the fish was estimated in each treatment and the daily feeding rate calculated based on three percent body weight. Half of the daily ration of food was given at 0900 and 1700 hours.

Visibility, pH, total hardness, salinity and temperature were monitored eleven times, with a secchi disk, comparator water-chex water test units, refractometer and thermometer, respectively. General observations were made periodically of the water color, amount of algae, and water conditions. On March 7 and March 10, 1980, all tilapia were harvested, and data on total weight and number of tilapia were recorded.

RESULTS

Visibility, pH, total hardness, temperature, and salinity values (Table 1) were similar between the pools. The values for total hardness were high, averaging 610. Values of 300 mg/l or higher are considered to represent hard water. Visibility ranged considerably and was primarily affected by algae blooms.

Values for pH, temperature, and salinity were within normal limits for culturing tilapia.

Fish fed the tilapia food exhibited length increases and weight gains of approximately four times those fed the whole oats (Tables 2 and 3). Reflecting these differences, the index of condition values (Bennet, 1971), which indicate relative plumpness of fish, were 1.20 and 2.23 for the fish fed oats and tilapia food, respectively. As indicated by the feed conversion factors (Table 4), a much higher proportion of the tilapia food than the oats was assimulated by the fish.

Clearly, the tilapia food out performed the oats, and several factors may have attributed to this. First, the oats were not as readily consumed by the tilapia and by the end of the study some of the oats had accumulated at the bottom of the pool. Conversely, fish fed aggressively on the tilapia food. Secondly, reproduction was probably a factor. Reproduction for treatment one was twice that for treatment two (Table 4) and thus more energy was devoted to reproduction in the first treatment. Energy channeled into reproduction would not be available for individual growth. Also, as feeding rates were not adjusted to account for reproduction, the higher density of fish in treatment one may have increased competition for food and caused stunting.

Although not conclusively tested in this study, the locally milled fish food is presently used by the Joe Perez tilapia farm with good results. Both milled foods appear to be more suitable for tilapia production than the whole oats.

The oats, hybrid tilapia, and local fish food are priced at \$0.30, \$0.62 and \$0.36 per kilogram,respectively. The actual cost, in this study, for raising the tilapia on oats and hybrid tilapia food was \$0.96 and \$0.64 respectively, per kilogram of fish weight gain. If the tilapia on the local feed had a similar feed conversion as the hybrid tilapia feed from Taiwan, it would cost about \$.37/kg to raise them. A local tilapia farmer presently sells his tilapia at \$.73/kg and thus it may be more profitable to use the local tilapia feed because of the lower feed cost.

RECOMMENDATION

For optimal hybrid tilapia production, the milled food appears to provide the best growth. The use of oats should be discouraged, unless it is used as a supplemental food.

Table 1. Physical and Chemical Parameters for Treatments with Hybrid Tilapia (*Sarotheradon mossambica* X *S. nilotica*) at Tilapia Farm, Fadian Point, Guam.

PARAMETER	WHOLE OATS		23% PROTEIN TILAPIA FOOD	
	Range	Mean	Range	Mean
pH	7.5 - 7.9	7.6	7.3 - 8.1	7.7
Hardness	500 - 700	620	500 - 700	600
Temperature (°C) Air	25.5 -33.0	28.5	25.5 -33.0	28.6
Temperature (°C) Water	28.0 -32.0	30.0	28.0 -32.0	30.0
Salinity (R.I.) %	0.0 - 1.1	.10	0.0 - 1.1	.10
Visibility (cm)	45 - 90	70.7	35 - 95	66.4

Hybrid tilapia used in feeding experiments.

Worker feeding hybrid tilapia.

Table 2. Bi-weekly Sample and Harvest Data for Treatment Number One (Whole Oats) with Hybrid Tilapia (*Sarotheradon mossambica X. S. nilotica*) at Tilapia Farm, Fadian Point, Guam.

DATE	MEAN LENGTH (cm)	MEAN WEIGHT (g)	INDEX OF CONDITION	WEIGHT OATS (kg)
11/9/79	10.90	30.90	2.01	00.00
11/27/79	12.44	37.14	1.42	17.61
12/11/79	11.77	34.12	1.64	33.04
1/2/80	11.97	41.83	1.87	45.03
1/17/80	11.14	30.56	1.80	18.75
1/30/80	11.76	33.44	1.61	11.92
2/14/80	11.94	33.15	1.50	15.04
2/29/80	12.44	42.10	1.61	14.92
3/10/80	-	-	-	12.60
TOTAL	-	-	-	168.91
MEAN	11.80	35.41	1.68	-
GAIN FOR 113 DAYS	1.54	11.1	-	-
GAIN PER DAY	.01	.10	-	-
WEIGHT FEED PER DAY	-	-	-	1.37

Table 3. Bi-weekly Sample and Harvest Data for Treatment Number Two (Tilapia Food) with Hybrid Tilapia (*Sarotheradon mossambica* *X*. *S*. *nilotica*) at Tilapia Farm, Fadian Point, Guam.

DATE	MEAN LENGTH (cm)	MEAN WEIGHT (g)	INDEX OF CONDITION	WEIGHT HYBRID TILAPIA FEED (kg)
11/9/79	10.60	28.33	2.07	00.00
11/27/79	11.55	34.34	1.77	16.13
12/11/79	11.05	36.25	2.23	30.52
1/2/80	13.78	60.40	1.53	47.54
1/17/80	15.56	90.93	1.42	27.15
1/30/80	15.01	79.10	1.43	35.45
2/14/80	16.85	105.25	1.20	35.59
2/29/80	15.62	79.54	1.22	47.36
3/7/80	-	-	-	16.73
TOTAL	-	-	-	256.67
MEAN	13.75	64.27	1.61	-
GAIN FOR 113 DAYS	5.02	51.21	-	-
GAIN PER DAY	.04	.45	-	-
WEIGHT FEED PER DAY	-	-	-	2.14

Table 4. Hybrid Tilapia (*Sarotheradon mossambica* X. *S. nilotica*) Feeding and Harvest Data at Tilapia Farm, Fadian Point, Guam for the Production Period From November 9, 1979 - March 10, 1980.

	Whole Oats	23% Protein Tilapia Feed
Initial Weight all Tilapia	30.90	28.33
Final Weight of all Tilapia (Kg)	33.25	86.95
Weight Gain (Kg)	2.35	58.62
Total Weight of Feed (Kg)	168.91	256.67
Feed Conversion Factor	71.87	4.40
Average Weight Per Tilapia (Kg)	.03	.08
Total Number of Tilapia	1111	1051
Total Number Reproduction	111	51
Percent Reproduction	10	5

FRESHWATER PRAWN, *MACROBRACHIUM ROSENBERGII*, DEMONSTRATION PROJECT

SUMMARY

A freshwater prawn pond culture project at Merizo showed that the prawns had good growth rates on Guam. From November 7, 1979 to August 16, 1980, the pond had a 50% mortality of prawns. Two prawn kills occurred during the study and were probably caused by low dissolved oxygen levels. Major costs in rearing prawns were for the post larvae, food, and labor.

BACKGROUND

The culture of the freshwater prawn, *Macrobrachium rosenbergii*, has been encouraged on Guam because of the suitable climate and availability of land. However, to stimulate investment in prawn culture, establishment of the economic viability of such ventures, and a demonstration of culture techniques are needed.

OBJECTIVES

I. To demonstrate proper freshwater prawn, culture procedures.

II. To provide information on the economic potential of culturing freshwater prawns.

PROCEDURES

The prawn pond used in this study is located in a low, flat-land area in Hautan, Merizo, Guam. The pond measures about 42 meters by 78 meters (3276 m^2). Water for the pond is electrically pumped from a nearby well, and can be drained with a stand-pipe. The pond was filled from November 2-4, 1979. After reaching the proper level, water was periodically added to maintain the optimal water level and water quality.

The University of Guam Soil Research and Testing Laboratory examined the pond soil twice during the production period using the standard methods for soil analyses (Table 1). The pH of soil was slightly alkaline but within the normal range for freshwater pond soils. Phosphorus values were low, while potassium, calcium, and magnesium were high. The percentage of organic matter in the pond increased during the study. The soil consisted primarily of clay and silt, which are necessary for water retention in ponds.

The freshwater prawn, post-larvae for the project were air-shipped from Hawaii and an estimate of the mortality resulting from shipping, handling, and stocking was made. The number of dead was estimated in the shipping bags. Also, one hundred post-larvae were placed in a screened box in the pond and the mortality for a 24 hour period recorded. On November 7, 1979, 101,200 prawn post-larvae were stocked into the pond at a density of 30.9/m^2.

The pond was fertilized with both organic (97%) and inorganic (3%) fertilizers. A total of 834.6 Kg of organic fertilizer added to the pond, of which, 81%

Table 1. Soil Sample Data from Baza Freshwater Prawn (*Macrobrachium rosenbergii*) Pond at Merizo, Guam

DATE	MARCH 31, 1980	AUGUST 20, 1980
pH	7.05	7.49
P	6.56 ppm	15.03 ppm
K	325 ppm	320 ppm
Ca	3,000 ppm	6,600 ppm
Mg	1,040 ppm	1,200 ppm
Na	117.60 ppm	70.56 ppm
% O.M.	2.18	4.04
Texture		
% Clay		49.6
% Silt		36.8
% Sand		13.6

Table 2. Physical and Chemical Parameters for Baza Freshwater Prawn (*Macrobrachium rosenbergii*), Pond at Merizo, Guam.

	pH	Hardness (mg/l)	Temperature Air	Temperature Water	Salinity (R.I.^{o}/oo)	Visibility (cm)
RANGE	7.7-8.3	200-400	25.5-33.5	27.5-34.5	0.0-1.7	10-75
MEAN	8.2	300	28.1	31.2	0.1	37.5

(675.9 Kg) was wet, cow dung, 14% (113.4 Kg) dry chicken manure, and 5% (45.4 Kg) wet pig manure. The organic manure was broadcast over the pond bottom before filling and nineteen times on to the water surface after filling. A total of 25.4 Kg of inorganic fertilizer was added to a table at mid-water depth ten times. 15-15-15 made up 93% (23.6 Kg) of the inorganic fertilizer and the remaining 7% (1.8 Kg) was 16-16-16. Inorganic fertilizer was added after one month to stimulate a slight phytoplankton bloom; thus, shading the pond bottom and preventing vascular plant growth.

The aim in pond fertilization was to maintain a visibility of 35 cm in the water column. If the visibility was less than 35 cm, or low oxygen suspected, fertilization was discontinued until the visibility reached 35 cm.

The addition of fertilizer to the pond was discontinued on March 22 because the visibility remained below 35 cm. The locally made prawn food (28% protein), manufactured by Hunt and Behrens, Inc., was used. Initially, some prawn food was broadcast into the corners of the pond where the prawn post-larvae were to be released. After stocking, prawn feeding was based on 5% prawn biomass in the pond and had to be adjusted to account for prawn growth and pond conditions.

Monthly, fifty prawns were sampled to obtain length-weight data, from which feeding rates, growth rates and harvest dates were determined. At harvest time, twenty-five prawns were randomly sampled to obtain length-weight data. A measuring board and triple beam balance were used.

On most visits to the pond, visibility, pH, total hardness, temperature, and salinity were monitored with a secchi disk, comparator, water-chex water test units, thermometer, and refractometer, respectively. On June 3, 1979, water samples were analyzed for dissolved oxygen by the Water Resources Research Center of the University of Guam, using the standard Winkler method.

Periodically, harvests were conducted to remove prawn biomass, create more space for growth and reduce cannibalism. Harvest dates were dependant on personal schedules, size of prawns and the number of days from the last harvest. The harvests were timed to allow for growth of the larger prawns. Prawns were harvested with a fine meshed seine, counted, placed on ice, weighed on a table scale, and bagged. The prawns were selectively harvested by removing the large prawns and berried females.

RESULTS

Visibility, pH, total hardness, temperature and salinity were examined twenty-three times during the study (Table 2). The pH values were within the normal range; but, tended to be a little basic. Water hardness varied little during the study and the mean value of 300 is considered high. The temperature and salinity readings were within expected values. Visibility varied in response to fertilization, feeding and phytoplankton blooms and decreased from 75 cm to 10 cm during the study.

Biological observations were made of the pond throughout the production period. As prawns preferred areas with vegetation for protection, most of the aquatic plants along the edge of the pond were removed to facilitate their capture. Juvenile prawns were attracted to the water intake area. They could be seen circling the pond during the first month. The algae, organic matter, and organic manure often collected on the windward side of the pond. The water colors for the pond varied between clear, green, brown, and gray during the study.

The total amount of feed added to the pond was 4923 Kg, or an average of 17.3 Kg. The amount of food added per day peaked in May at 55.5 Kg. This rate was continued for twenty-seven days, until a prawn kill occurred on May 7, 1980. The amount of food given was decreased until the final harvest on August 16, 1980.

A 5% mortality loss was incurred during the shipment of post-larvae from Hawaii and initial stocking into the pond. Of the 101,200 prawns stocked, 45,513 prawns were harvested; 5,400 were transferred to a nearby pond, and the prawn mortality was 50,287. Mortality was due to catastrophic prawn kills, natural causes, and probably cannibalism.

Prawn kills occurred on April 3 and May 7, and low oxygen levels were suspected as the cause. Over fertilization or feeding can stimulate algae growth, and cause oxygen levels to drop to critically low levels during the night and early morning hours when the respiratory demands of the algae are highest.

Intense algae blooms were present during both prawn kills. Feeding was discontinued for four days after each kill. Water was siphoned from the pond bottom and freshwater pumped in from the well however, these corrective measures seemed to have no effect on the algae blooms. Dissolved oxygen was monitored on June 3, 1980 and the occurrance of low oxygen levels in the early morning was apparent (Table 3).

The first harvest was conducted after four months of growth and the prawns had attained a mean length of 9.2 cm and mean weight of 17.5 gms. (Table 4). This is good growth for prawns and in comparison, cultured prawns in Hawaii are usually not harvested until after six months. The consistently warm climate on Guam probably accounts for a better annual growth rate than on Hawaii. A total of 16 harvests were made, averaging 46.4 kg each and 63.5 prawns per kg.

Prawns can be profitabily reared in ponds on Guam with careful management and proper training (Table 5). A 23% net profit was realized during this operation, and the cost for post-larvae accounted for 46.1% of the total operating costs of this study. This could be reduced substantially if post-larvae were available from a local prawn hatchery and the costs for handling and shipping could be eliminated. The cost for feed (24.3%) could be reduced by feeding prawns at a feeding rate below 5% body weight. Labor costs were 20.4% of the total. Pond harvesting of prawns is very labor intensive because of the work involved in handling the seine and selecting market size prawns. A seine designed to capture large prawns could save

Table 3. Dissolved Oxygen Data for Baza Freshwater Prawn (*Macrobrachium rosenbergii*), Pond on June 3, 1980 at Merizo, Guam.

LOCATION	TIME	TEMPERATURE (°c)	DISSOVED OXYGEN (ppm)
Surface	4:52 am	28	3.28
Surface	5:52 am	28	2.78
Bottom	5:52 am	28	1.77
Surface	6:52 am	28	3.40
Surface	12:20 pm	33.5	16.07
Surface	1:30 pm	33.5	15.67

Table 4. Length-weight and Harvest Data from Baza Freshwater Prawn, (*Macrobrachium rosenbergii*), Pond at Merizo, Guam

DATE	Mean Length (Tip telson to (eye socket, cm)	Mean Weight (gm)	Total Number Harvested	Total Weight (kg)	Number Prawn Per Kg
11/7/79	1.0	<.1	-	-	-
12/10/79	2.9	.8	-	-	-
1/11/80	5.1	3.3	-	-	-
2/9/80	6.9	8.4	-	-	-
3/5/80	7.1	10.7	-	-	-
3/13/80	9.2	17.5	892	15.0	59.5
3/31/80	8.7	18.4	-	-	-
4/3/80	9.2	18.4	2287*	41.8	54.7
4/11/80	9.1	17.6	2807	41.8	67.2
4/17/80	9.9	22.7	2473	43.4	57.0
4/23/80	10.0	26.4	3249	66.8	48.6
4/25/80	-	-	1738	32.5	53.5
5/2/80	9.7	20.3	5179	99.1	52.3
5/7/80	8.0	15.7	10,234*	121.8	84.0
5/8/80	5.4	5.6	-	-	-
6/5/80	10.1	27.9	2935	62.3	47.1
6/6/80	-	-	424	7.7	55.1
6/11/80	9.0	16.9	4133	71.4	57.9
6/25/80	8.9	16.1	2219	33.4	66.4
7/6/80	-	-	331	3.9	84.9
7/8/80	-	-	885	10.2	86.8
7/10/80	4.7	3.0	-	-	-
7/10/80	8.2	13.1	1125	13.6	82.7
8/15/80	7.8	14.1	-	-	-
8/17/80	8.6	16.3	4602	78.2	58.9
TOTAL	-	-	45,513	742.9	-
MEAN	-	-	-	46.4	63.5

* Estimated Number of prawns

Table 5. Economic Analysis for Rearing Freshwater Prawns, (*Macrobrachium rosenbergii*), at Merizo, Guam from November 7, 1979 - August 16, 1980.

ITEM	COST	PERCENTAGE
Prawns		
101,200 Post Larvae	$ 2,530.00	
Packaging	115.00	
Shipping	803.25	
	$ 3,448.25	
Tax	17.24	
	$ 3,465.49 *	46.1
Fertilizer - Organic (Chicken, Cow, Pig)	no cost	
Fertilizer - Inorganic		
16 - 16 - 16	$ .66	
15 - 15 - 15	8.49	
	9.15	.1
Electricity	$ 645.51	8.6
Feed	1,821.49	24.3
Ice	36.00	.5
Labor	1,535.95	20.4
TOTAL OPERATING COST	$ 7,513.59	100
Income	9,806.94	
Total Operating Cost	7,513.59	77
NET PROFIT	$ 2,293.35	23%

* Subsidized by Government of Guam

time in handling the prawns at harvest time. Electricity to run the pumps could be reduced by running the pump less and only at critical times. Perhaps, a cost effective, electric aerator could be used instead of pumps during periods of low oxygen levels in the pond.

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Report prepared by Wayne Kruckenberg

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-1 Game Mammals
Study 1 Management of Guam Deer

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer.

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

The antlered-only deer hunting restriction imposed in 1978 continued this year, and no special hunts were authorized. Hunting license sales increased for the second year in a row. The Naval Communication Area Master Station (NCS) was the most popular hunting area. Analysis of spotlight count data indicated a significant increase in deer numbers on Andersen Air Force Base (AAFB) and a non-significant, though continued, decline on Naval Magazine (NAVMAG). A feasibility study of the use of deer pellet group counts to monitor population levels was completed.

BACKGROUND

The Guam deer is present in huntable numbers in several localities and therefore has an economic value in terms of recreation, as a utilizable food resource, and as an ecological component of forest communities. Human population pressures are, however, increasing due to a rapidly expanding population and the desire for economic growth and development. Coincident increases in hunting and other forms of recreation that affect wildlife have been predicted and estimated (Johnsrud et al 1966, Souder 1979). The problem is to manage local populations of deer on a sustained yield basis so that this recreation, food and wildlife resource will continue to be available in the future.

The Guam deer has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. The distribution has been mapped and the population trends as well as herd compositions have been determined by conducting night spotlight counts. In addition, statistics on deer hunting have been compiled since 1968 through hunter reporting procedures (AWR 1969-1978). These procedures made it possible to estimate the legal deer kill and the amount of legal hunter effort expended each deer season.

Researchers of Guam deer biology in the 1960's have collected the following information: A list of food plants, a preliminary table for aging Guam deer by tooth eruption and wear, morphological measurements, some parasites, the relative importance (percentages) of a number of known mortality factors, and a life table of the Andersen Air Force Base herd. All available data collected prior to fiscal year 1979 has been analyzed and synthesized in the form of a Final Report (Wheeler, 1979a).

OBJECTIVES

To determine the current size and distribution of the population of deer on Guam and to monitor population trends.

PROCEDURES

1. Continue monthly spotlight counts on Naval Magazine and Andersen Air Force Base, with periodic spotlight counts in other areas.
    a. Record number, age, sex and group composition.
    b. Statistically analyze count data and compare with past data to discern population trends.
2. Investigate the feasibility of using additional census methods, such as pellet group counts, to refine population estimates and knowledge of distribution.
    a. Conduct surveys and censuses in areas such as the Bolanos Conservation Area, where spotlight counts are not feasible.
    b. Attempt to correlate spotlight count data with actual deer abundance on AAFB by determining the change in sex ratio after buck-only special hunts.
    c. Attempt to determine a pellet group index that may be used to estimate deer abundance and/or habitat utilization.
3. Collect hunting statistics by requiring hunters to return hunter report cards. Analyze these statistics for changes in hunter kill, hunter effort and fill locations.

RESULTS

Hunting license sales continue to increase during fiscal 1980, to a total of 341 licensed hunters. This is an 8.9% increase over the previous fiscal year. For the second year in a row, deer hunting has been restricted to antlered deer only, with a season limit of one (1).

Fifty-five hunters returned their hunter report cards (16.1% return), and of these, 32 indicated that they had hunted deer (Table 1). Eight deer were reported taken from the following areas: NCS (6), AAFB (1), and Anao (1). These ranged from spike to 6 point buck (3 pt.) and had an average reported weight of 80.3 kg (Range 34.1-95.5 kg).

Of those hunters who returned their hunter report cards, nearly half indicated that they hunted at NCS, making it the most popular area in which to hunt. This is probably because it was open to hunting on a daily basis throughout the season and is easily accessible to a large segment of the hunting public. Northwest Field on the other hand, was open only on weekends and holidays, and hunters were allowed entry only at certain hours on those days. Of non-military areas, the Bolanos Conservation Area had the greatest reported hunting pressure. Table 2 presents the island-wide distribution of hunting pressure based upon the hunter report cards returned.

Table 1. Island-wide deer hunting statistics, Fiscal Year 1980.

a.	License Sales	341
b.	Number of Hunters Reports Returned	55
c.	Percent returned:	16.1%
d.	No. reporting hunters who hunted deer:	32
e.	Percent of reporting hunter who hunted deer:	58.2%
f.	No. deer report cards returned:	32
g.	No. deer taken by 21 hunters:	8
h.	Hunter success (gx100)/d):	25%
i.	Estimated total number of legal deer hunters (a/e):	198
j.	Estimated total legal deer take (hxi):	50
k.	No. of 8 hr. hunter days expended by 21 reporting deer hunters:	188
l.	Average no. days each hunter spent:	5.9
m.	Estimated total no. deer hunter days (ixl):	1164.4
n.	No. hunter days per deer taken (K/g):	23.5

Table 2. Island-wide distribution of hunting pressure based upon returned hunter report cards.

LOCATIONS	NO. HUNTERS	NO. MAN-HOURS	NO. DEER TAKEN	NO. PIGS TAKEN
NCS	23	1363	6	11
NWF	9	290.5		9
AAFB	4	420	1	
AAFB/South	1	48		1
NAVMAG	3	28		
Anao	2	9	1	
Barrigada	1	10		1
Bolanos	6	77		
Cross-Island	5	18		1
Inarajan	1	6		
Maagas	1	4		
Pagat	3	10+		5
Talofofo	1	not reported		1
Uruno	1	12		1

HUNTER CHECK STATION DATA

Hunter logs were kept throughout the deer and pig season at two hunter check stations: the NCS security desk and the NWF entrance gate at Potts Junction. Hunters were required to sign in and out and to report any game taken. Hunter effort and kill data were obtained by compiling data from the days of these two areas (Table 3).

Table 3. Hunter effort and deer take according to Official Hunter Logs from Naval Communication Area Master Station (NCS) and Northwest Field (NWF).

	NCS				NWF			
	# GUN SORTIES	# BOW SORTIES	DEER TAKE		# GUN SORTIES	# BOW SORTIES	DEER TAKE	
			GUN	BOW			GUN	BOW
October	785	17	5	1	221	30	1	
November	346	20	-	-	266	36	2	1
December	299	24	4	-	144	55	-	-
TOTAL MAN-HOURS	4720.5				2657			
TOTAL MAN-DAYS	590				332			

SPOTLIGHT COUNT TRENDS

Monthly spotlight count data at Andersen Air Force Base (AAFB) (Table 4) and Naval Magazine (NAVMAG) (Table 5) were statistically analyzed and compared using the Mann-Whitney U-Test (Table 5) (Sokal and Rohlf, 1969). The FY 1980 count data from AAFB were significantly different ($P<.05$) from the FY 1979 data, indicating that the deer population in the area censused may be increasing.

The NAVMAG deer count data from FY 1979 and FY 1980 were not significantly different; however, the mean number of deer seen per count in FY 1980 was lower than the preceding year, continuing a trend that has lasted since FY 1977.

As discussed in the FW-2R-16 Job Progress Report for this job, spotlight counts are not the most sensitive indicator of deer population levels and substantial changes in population level must take place before significant changes will be detected. Because of man-power shortages, it has not been possible to increase the intensity of sampling with spotlight counts as recommended in the previous report. Trends are indicative, however, and it does appear that the NAVMAG deer population may be decreasing, perhaps due to continual poaching pressume. The AAFB population in the census area is likely now on an upswing, perhaps due to the cessation of the special hunts that took place in the area between August, 1968 and June, 1978.

Table 4. Andersen Air Force Base deer herd composition count, FY 1980.

	1979			1980										
	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	TOTAL	AVE. NO./COUNT	ST. DEVIATION
Spike	2	2		1		5	2	4	2	6	2	2	28		
2 Pt.	1	3			1	2	1	6	1	8	9	13	45		
3 Pt.	4	6	4	2	4	5	6	2			2	2	37	9.8	± 4.33
4 Pt.			1						2				3		
Unclassed o		2	1		1								4		
Doe	12	28	22	21	11	44	37	45	7	27	33	26	313	26.1	± 12.37
Yearling	3	5	7	7	2	4	8	6	5	6	7	12	72	6	± 2.59
Fawn	3	3	2	4		3	3	2	7	4	3	9	43	3.6	± 2.35
Unclassed	14	14	7	5	10	6	14	15	6	11	10	4	116	9.7	± 3.98
Total	39	63	44	40	29	69	71	80	30	62	66	68	661	55.1	± 17.54
Miles Traveled	39.7	4.7	4.7	5.1	5.1	5.2	7.5	4.7	4.8	4.5	4.7	3.8	60.5	5.0	± .9
Deer/10 Miles	68.1	133.3	93.1	77.9	56.5	131.9	156.9	169.3	62.2	13.7	139.7	177.8	1403.7	11.7	± 43.26

Table 5. Naval Magazine deer heard composition count, FY 1980.

	1979			1980											
	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	TOTAL	AVE. NO/COUNT	ST. DEVIATION
Spike	1		1				1						3	1.9	± 1.16
2 Pt.			1	1	2			1	2	1		1	9		
3 Pt.				2	2		1	1					6		
4 Pt.															
Unclassed o		3	1			1							5		
Doe	3	12	3	4	15	6	8	10	8	2	8	10	89	7.4	± 3.99
Yearling	1	1	2	1	1	2	1	2	1				12	1	± .74
Fawn	1	2	2		5	3	2	1		1			17	1.4	± 1.51
Unclassed	2	8	4	7	7	4	1	2	4	2	7	3	5.1	4.3	± 2.42
Total	8	26	14	15	32	16	14	17	15	6	15	14	192	16	± 6.98
Miles Traveled	11	13.7	13.4	13.4	13.4	13.7	13.3	14.2	9.1	12.6	12.9	13.2	153.9	12.8	± 1.42
Deer/10 Miles	7.2	18.9	10.4	11.1	23.8	11.6	10.5	11.9	16.4	4.7	11.6	10.6	148.7	12.4	± 5.12

Table 6. Comparison of deer spotlight counts at Andersen Air Force Base and Naval Magazine between Fiscal Year 1979 and Fiscal Year 1980. Significant differences between years determined using the Mann-Whitney U-Test.

	AAFB		NAVMAG	
	FY79	FY80	FY79	FY80
No. Counts	12	12	12	12
Maximum Count	70	80	61	32
MEAN/Count	37.8	55.1	25.3	16
Std. Deviation	± 17.13	± 17.54	± 14.75	± 6.98
Coefficient of Variation (%)	45.3	31.8	58.2	43.6
Significant Difference	P<.05		NS	

PELLET GROUP INDEX

Work was completed during this segment on an investigation of the feasibility of using pellet group counts as a means of assessing deer use in areas where spotlight counts are not feasible. This feasibility study was reported in an unpublished manuscript by Michael E. Wheeler. This manuscript is included in its entirety as Appendix 1 to this report.

RECOMMENDATIONS

1. Increase the effort directed at determining deer populations in areas other than AAFB and NAVMAG. Continue to explore the application of pellet group counts and other methods as indices to deer abundance.

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Report Prepared by Robert D. Anderson

APPENDIX I

A Feasibility Study for Using the Pellet Group Count Technique as a Measure of Abundance of Guam Deer

By
Michael E. Wheeler

A Feasibility Study for Using the Pellet Group Count Technique as a Measure of Abundance of Guam Deer

By Michael E. Wheeler

The pellet group count technique has been developed and used as a method for obtaining an index of abundance of North American cervids and the subject was comprehensively reviewed by Neff (1968). Sophisticated statistical analyses suitable for such studies have since been developed (McConnell and Smith 1970, Bowden et al. 1967, White and Eberhardt 1980). There is a need on Guam to develop a deer abundance indicator that may be used in areas not suitable for censusing with night spotlight counts (Wheeler 1979). The purpose of this study was to correlate deer density as determined by night spotlighting with deer pellet group density in the same area.

METHODS

The study area consisted of a strip of low-growing herbaceous vegetation on the ecotone of limestone forest. The strip was 25 m wide and 1.6 m long and conformed to the contour of the forest edge at the end of the flightline on Andersen Air Force Base (Fig. 1). Two 400 m transects were established within the strip and the centers of 100 m^2 circular plots were established at the ends and at 100 m intervals along the transects. Ten plots were thus established, encompassing a total of 1000 m^2. This amounted to 2.5% of the area of the strip. Deer were counted montly in the strip by conducting night spotlight counts as described by Wheeler (1979). During the day prior to each count each plot was searched for pellet groups and all pellet groups located on the plots were painted white with white spray paint. The pellet group plots were again searched for pellet groups the day following the spotlight count and all new pellet groups were recorded. For each month the ratio of the number of new pellet groups in the plot to the number of deer sighted was calculated. To determine how many months data should be collected, the following formula (Neff 1968, DeVos and Mosby 1969) was used:

$$N = \frac{(t_{0.10})^2}{(0.10 \times \underline{X})^2}$$

where N = number of counts
$\underline{S}^2$ = variance of preliminary data
$\bar{X}$ = mean of preliminary data
0.10 = selected risk factor
$t_{0.10}$ = tabular value for the selected level of probability

All counts were conducted between September 1, 1979 and March 31, 1980.

RESULTS AND DISCUSSION

The number of deer sighted in the study area varied from 16 to 32 (Table 1). An adequate sample size was obtained after seven counts.

Table 1. Numbers and densities of deer and new pellet groups in the study area, and the ratio of the number of new pellet groups per deer-night.

Month	No. Deer Per 4 ha	No. Deer Per ha	No. Pellet Groups Per .1 ha	No. Pellet Groups Per ha		Pellet Groups Per Deer-Night
SEP.	32	8.0	10	100		12.5
OCT.	16	4.0	6	60		15.0
NOV.	32	8.0	9	90		11.2
DEC.	13	3.2	5	50		15.6
JAN.	30	7.5	9	90		12.0
FEB.	24	6.0	8	80		13.3
MAR.	22	5.5	6	60		10.0
					$\overline{X}$	12.9
					σ	1.8

The number of pellet groups per deer is of the same order of magnitude as that reported for other cervids. The density of pellet groups was high, with an average of 90% of the plots having pellet groups and an average of 53% of the plots having new pellet groups (Table 2).

Table 2. Pellet group density

Month	Plots with Any Pellet Groups No.	Plots with Any Pellet Groups Percent	Plots wth New Pellet Groups No.	Plots wth New Pellet Groups Percent
SEP.	10	100	7	70
OCT.	9	90	5	50
NOV.	9	90	5	50
DEC.	9	90	5	50
JAN.	9	90	6	60
FEB.	8	80	4	40
MAR.	9	90	5	50
Mean		90 ± 5		53 ± 9

Correlation

A significant ($P<.01$) correlation was found in a product moment correlation test (Sokal and Rohlf 1969) of the number of new pellet groups observed versus the number of deer sighted during the night spotlight counts ($r = .95$). Such a strong correlation is not surprising as the strip was chosen so that most or all of the deer utilizing the area could be seen. The following equation describes the principle axis of the correlation and may be used to estimate deer abundance in other areas:

$$Y_1 = .080\ Y_2 - .1$$

where Y_1 = number of deer per hectare

Y_2 = number of new pellet groups per hectare per day

Since the data are highly correlated ($\lambda_1 = 7096$, $\lambda_2 = .15$), most of the variance can be accounted for by the principle axis. Confidence limits (95%) for the slope are $L_1 = .077$, $L_2 = .083$.

Density

According to Neff (1968), the requisite sampling intensity varies inversely with pellet group density. The area selected for this study has the highest known deer density, and hence the highest pellet group density of any place on Guam. It was thus possible to obtain significant data with a relatively moderate sampling effort, since pellet group sampling is more efficient in areas of high pellet group density. When the technique is applied to other areas on the island, a greater amount of sampling effort must be expected.

Sources of Error

According to Neff (1962, 1963) because of missed groups, pellet group density estimates will almost always be less than true density. There is also a possibility that not all deer in the study area were censused by the spotlight technique. A further check that would help to relate the two parameters would be to determine the defecation rate. Other sources of error mentioned by Neff were negligible. There was but a single observer so that sources of observer bias inherent in having a number of field workers were eliminated. The habitat sampled was relatively homogeneous stands of low herbaceous growth. The probability of missing pellet groups in such habitat would be less than in areas of dense or shrubby vegetation. Species identification was no problem, as the only other ungulate in the area, wild pigs, have a much different scat. There would be no loss of pellet groups by washing or insect attack in the period of one day.

Conclusions and Recommendations

The pellet group count technique may be used to estimate deer abundance on Guam, and an equation was determined that relates observed deer density to pellet group density.

As a further check on the pellet group - deer abundance relationship, the defecation rate of the Guam deer should be determined.

There is a possibility that night spotlight counts in some areas on Guam could be biased by the degree of illegal deer of illegal deer hunting at night with spotlights. A comparative study of the pellet group count technique on the Naval Magazine, where spotlight counts are also currently conducted, might be useful in elucidating such a problem.

Finally, areas not suitable for conducting night spotlight counts (Anao Conservation Area, Bolanos Conservation Area, and the ravine forests along the Ylig, Togcha, Ugum, and Talofofo Rivers), and areas where night spotlight counts have recently had negligible results Naval Communications Station, Northwest Field, and Tarague Beach area) should be surveyed with pellet group plots to better substantiate deer abundance in those areas.

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JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Movement and Home Range of Guam Deer

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To determine movement patterns, home range size, and patterns of habitat utilization of free-ranging Guam deer.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report Prepared by Robert D. Anderson

Female Guam deer.

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-1 Game Mammals
Study 2 Management of Wild Pigs

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Wild Pigs

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To prepare a status report on wild pigs to be used in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population size and distribution of wild pigs on Guam.

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Major activities under this job consisted of monitoring the harvest of pigs during the hunting season and analysing the harvest data. The estimated number of pig hunters increased substantially in FY 1980, with 80% of reporting hunters indicating that they had hunted pigs.

BACKGROUND

The wild pig (*Sus scrofa*) is one of Guam's two game mammals. The wild pigs on Guam decend from stock introduced by the Spanish sometime during their three-hundred year role on Guam. Wild pigs are found island-wide, though appear to be most numerous in the limestone forests of the north and the ravine and swamp forests of southern Guam.

Prior to 1964, wild pigs were not included on the game list and were hunted all year with no limit. In 1964, pigs were declared a game animal; the season was year-long with a limit of one pig per day. In 1973, based on evidence compiled by the Division, the wild pig season was reduced to a three month period, October to December. The limit continued at one pig per day until 1978, when it was reduced to 10 per season.

The bulk of fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may be under-harvested and where crop damage by pigs is a common complaint.

OBJECTIVES

To determine current population size and distribution and monitor trends.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other field work.

2. Conduct surveys using counts, flushing counts, or other methods, to determine the relative abundance of pigs in the Bolanos Conservation Area.

3. Monitor the harvest of pigs during the legal hunting season.

RESULTS

Hunter Reports and Harvest Data

The estimated number of pig hunters increased substantially in FY 1980, with 80% of the hunters who returned their hunter report cards indicating that they hunted pigs (Table 1). Forty-three percent of these pig hunters were successful with an average take of 1.42 pigs per successful hunter. An estimated 273 pig hunters spend an average of 5 eight-hour days hunting pig; the estimated total legal pig harvest was 118.

The results of the hunter report card survey are presented in Table 2 of Job Progress Report W1-1-1 (Guam Deer). Table 2 of this report presents a breakdown of hunter effort and pig harvest according to the official hunter logs from NCS, NWF and Naval Magazine (NAVMAG). Basically, NCS was the most heavily hunted and most productive area, with 28 officially recorded pigs harvested. Naval Magazine was opened to NAVMAG personnel for two days of pig hunting in December; eighteen hunters participated and harvested one pig.

In spotlight counts conducted for deer during FY 1980 on both NAVMAG and NWF, only one pig was seen at NAVMAG. Because of behavioral characteristics of pigs and the dense nature of their preferred habitat, spotlight counts are not the best means of assessing numbers and some other method must be developed. Because of manpower shortages, no effort was made to determine pig populations in the Bolanos Conservation Area or other interior areas where access is limited.

RECOMMENDATIONS

Continue to monitor hunting seasons and hunters harvest of pigs. As manpower becomes available, increase management and research activities, particularly in southern and interior non-military areas.

Report prepared by Robert D. Anderson

Table 1. Island-Wide Pig Hunting Statistics

a.	License sales:	341
b.	No. hunter reports returned:	55
c.	Percent returned $(\frac{b}{a} \times 100)$:	16.1%
d.	No. reporting hunters who hunted pigs:	44
e.	Percent of reporting hunters who hunted pigs $(\frac{d}{b} \times 100)$:	80%
f.	No. successful pig hunters:	19
g.	Percent reporting pig hunters who took pigs $(\frac{f}{d} \times 100)$:	43.2%
h.	No. pigs taken by 19 hunters:	27
i.	Average No. pigs per successful hunter $(\frac{h}{f})$:	1.42%
j.	Estimated total no. legal pig hunters (axe):	273
k.	Estimated total No. legal pigs taken (axexi):	118
l.	No. 8 hr. days expended by 37 reporting pig hunters:	185.3
m.	Average No. days each hunter spent:	5
n.	Estimated total No. pig hunter days (jxm):	1365
o.	No. pig hunter days per pig taken $(\frac{n}{k})$:	11.5

Guam wild pig.

Table 2. Hunters effort and pig harvest according to offical hunter logs from Naval Communication Area Masters Station (NCS), Northwest Field (NWF), and Naval Magazine (NAVMAG).

	NCS				NWF				NAVMAG	
	#Gun Sorties	#Bow Sorties	Pig Take		#Gun Sorties	#Bow Sorties	Pig Take		#Gun Sorties	Pig Take
			Gun	Bow			Gun	Bow		Gun
October	785	17	15	-	221	30	6	-	-	-
November	346	20	6	-	266	36	8	-	-	-
December	299	24	7	-	144	55	3	-	18	1
Total Man-days	4,720.5				2,657				117	
Total Man-days	590				332				14.6	

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-2 Game Birds
Study 1 Management of Philippine Turtle Doves

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Philippine Turtle Doves

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To prepare a status report on Philippine turtle doves for use in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R-17
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle Doves.

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Roadside counts indicate that Northwest Field (NWF) has the highest Philippine turtle dove population of the three areas censused, followed by the North-Central Route. The apparent population in NWF increased significantly in FY 1980, while a significant decrease in numbers was noted on the North Central route. An estimated 43 dove hunters harvested an estimated 338 doves during the month-long hunting season.

BACKGROUND

The Philippine turtle dove (Streptopelia bitorquata) is currently the only game bird on Guam. It was introduced by the Spanish about 1771 from the Philippines (Baker, 1951). The Philippine turtle dove has been a regulated game bird since the first hunting season was established in 1965. The current hunting season is July 1 to July 31, with a daily limit of two birds and a season limit of twenty. Although considerable work has been done in the past on nesting and movement of Philippine turtle doves (Drahos, 1977) current effort is restricted to roadside counts and monitoring of hunter harvest.

OBJECTIVE

To determine present population levels and distribution and monitor trends.

PROCEDURES

1. Continue bi-weekly roadside counts in three locations in northern Guam.
2. Begin roadside counts or call counts in other areas to determine distribution and relative abundance.
3. Monitor hunter harvest during legal season.

4. Based upon 1, 2, and 3 above, make recommendations for proper hunting season and bag limits.

RESULTS

Roadside Counts

The Northwest Field (NWF) area continues to have the highest populations of Philippine turtle doves of the three areas censused by roadside count (Table 1).

Roadside count data from FY 1979 and FY 1980 were compared using the Mann-Whitney U-Test (Sokal and Rolhf, 1969).

The mean number of birds of observed per 100 miles of travel on the NWF route increased significantly (P<.05) in fiscal year 1980 to 233.5 (Table 2), continuing an upward trend that started in 1977 (Jenkins, et.al 1979).

The mean number of doves observed per 100 miles of travel on the North-Central route continued to decline, with a significant (P<.05) drop from 111.1 in FY 1979 to 69.6 in FY 1980 (Table 2). This downward trend has been since this route was first censused in 1976, when 278.3 doves per 100 miles were observed, the highest recorded for any route (Jenkins, et.al. 1979). This consistent decline may be related to the continuing development of this part of Guam.

Population levels on the North route have been consistently lower than the other two, but have remained reasonably stable, slowly fluctuating between a high of 34.1 birds per 100 miles of travel in calendar Year (CY) 1977 and a low of 23.5 in CY 1974 (Jenkins, et.al. 1979). The mean count has gradually declined from that CY 1977 high to only 26.4 doves per 100 miles of travel in FY 1980 (Table 2).

Hunter Harvest

The 1980 Philippine turtle dove hunting season was July 1 - July 31, with a daily limit of four and a season limit of twenty birds. Table 3 presents the results of the hunter report card survey; only seven of the fifty-five hunters who returned this report card reported that they had hunted doves. The estimated total number of dove hunters was 43, with an estimated total harvest of 338 birds.

The only military land that was open to dove hunting was the Naval Communications Area Master Station (NCS). Hunters were required to check in and out through the Security Office. Table 4 present dove hunt statistics for NCS based upon the official hunting log maintained in the Security Office.

RECOMMENDATIONS

1. Continue bi-weekly roadside counts in three locations in northern Guam and begin additional roadside counts or call counts in other areas to monitor distribution and relative abundance of Philippine turtle doves.

Table 1. Number of Philippine turtle doves observed per 100 miles of travel on the Northwest Field (NWF), North-Central, and North roadside count routes during Fiscal Year 1980.

	1979			1980											
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	TOTAL	$\overline{X}$/COUNT	$\overline{X}$ 100 m
Northwest Field	215.1	97.9	168.0	245.7	82.6	295.1	252.1	282.2	224.9	333.3	362.8	122.8	659	28.62	223.5
North-Central	128.2	88.7	44.9	56.9	89.7	58.6	66.3	74.9	-	109.2	28.8	19.2	204	8.2	69.6
North	26.9	24.8	27.4	64.3	14.6	37.3	8.3	17.0	19.2	-	19.2	31.3	131	6.6	26.4

Table 2. Results of Northwest Field (NWF), North-Central, and North roadside counts of Philippine turtle doves conducted during FY 1979 and FY 1980, showing the mean number of birds seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different (P<.05) from the preceeding year as determined by the Mann-Whitney U-Test.

Location	FY 1979			FY 1980		
	$\overline{X}$	σ	CV	$\overline{X}$	σ	CV
NWF	172.5	79.6	46.1	233.5*	90.5	40.5
N. Central	111.1	28.2	25.4	69.6*	33.0	47.5
North	32.4	22.7	70.0	26.4	15.0	56.7

Table 3. Island-wide Philippine turtle dove hunting statistics.

a.	License sales:	341
b.	No. hunter reports returned:	55
c.	Percent returned ($\frac{b}{a}$ x 100):	16.1%
d.	No. reporting hunters who hunted doves:	7
e.	Percent of reporting hunters who hunted doves ($\frac{d}{b}$ x 100):	12.7%
f.	No. successful dove hunters:	6
g.	Percent reporting dove hunters who took doves ($\frac{f}{d}$ x 100):	85.7%
h.	No. doves taken by 6 hunters:	47
i.	Average No. doves per successful hunter ($\frac{h}{f}$):	7.8%
j.	Estimated total No. legal dove hunters (a x e):	43
k.	Estimated total No. legal doves taken (a x e x i):	338
l.	No. 8 hr. days expended by 6 reporting dove hunters:	25.5%
m.	Average No. days each hunter spent:	4.2%
n.	Estimated total No. dove hunter days (j x m):	181
o.	No. dove hunter days per dove taken ($\frac{h}{k}$):	.54

Table 4. Philippine turtle dove hunter effort and take at Naval Communications Area Master Station (NCS), based upon official hunter log.

a.	Total number of hunter sorties:	140
b.	Average number of hours per sortie:	3.26
c.	Total 8-hr. days expended hunting doves:	57
d.	Total No. doves recorded taken:	66
e.	No. dove hunter days per dove taken $(\frac{b}{c})$:	.86

2. Continue to monitor hunter harvest and adjust hunting seasons and bag limits to provide for sustained yield management of dove populations.

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Report Prepared by Robert D. Anderson

Philippine turtle dove

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W2 Game Birds
Study 2 Management of Black Francolin

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on the Black Francolin on Guam

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

A completely rewritten manuscript on the current status of the black francolin on Guam is in preparation and will be completed by September 30, 1981.

BACKGROUND

Data gathered from the time of the black francolin's original introduction in 1961 to surveys in 1968 and 1973 were compiled in an unpublished manuscript, "The Status of the Black Francolin on Guam", by Nick Drahos and Jack Jeffrey. The manuscript indicated the black francolin population was quite small and confined to a narrow section of southern savannah habitat.

Recent systematic surveys of southern Guam have shown a viable population of black francolin now exists (see Study 2, Job 2 of this report) and any status report would need complete revision to adequately cover the present program. Data gathered from a trial black francolin hunt will be incorporated into the final manuscript.

OBJECTIVE

To prepare a status report on the black francolin for use in formulating future hunting regulations.

PROCEDURES

1. Synthesize material from the past manuscript and field notes.
2. Research and review literature on the black francolin in both its native and exotic habitats.
3. Make recommendations on management needs and establish a limited hunting season should a viable population be found to exist.

RESULTS

Drahos and Jeffery's manuscript "The Status of the Black Francolin on Guam" has been thoroughly reviewed and valuable data have been retained for inclusion into the new report. All states involved in any black francolin introduction programs have been contacted and informative responses have been forthcoming.

Literature review has been completed and data gathered from the 1980 francolin survey has been compiled. Survey forms to gather biological data from francolins brought into hunting checking stations have been designed.

After an 8-month extensive survey of suitable savannah habitat, a population of approximately 4,600 black francolins was estimated in southern Guam. It was felt that such a population could withstand the impact of a limited hunt in early December.

In conjunction with surveying and researching these birds, it became clear a complete revision of the existing manuscript was needed. The completion of this new report will be an integrel part of Segment 18 studies.

RECOMMENDATIONS

1. Compile data from the present francolin surveys to determine abundance, density, distribution and breeding season as well as seasonal patterns in calling frequency.
2. Synthesize materials from the past manuscript and field notes for inclusion in the new report .
3. Compile data on age and sex ratios gathered from black francolins examined at hunter checking stations.
4. Make recommendations concerning future black francolin hunts and identify any management needs.

Report prepared by: Anne F. Maben

Black francolin

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

An eight month black francolin survey was completed which consisted of nine transect routes involving 91 fixed-distance circular plot censuses in southern savannah habitat. Results produced population estimates and densities of calling males and recommended a limited hunting season on francolins. A public meeting was held pursuant to Government Code of Guam, Section 12007 and 12321. Guam's first black francolin hunt was held on the weekends of December 6 & 7 and December 13 and 14, 1980.

BACKGROUND

As part of the Foreign Game Bird Introduction program of the U.S. Fish and Wildlife Service, our Division investigated the possibility of introducing game birds to Guam to provide sport and meat to local hunters. Black and gray francolins were chosen as prospective birds due to their popularity as game in their native northern India and the similarities in climate and habitat available on Guam (Bump and Bump, 1964).

In April, 1961, 171 black francolins were released in the Dandan area of southern Guam and 131 gray francolins were set free in areas of northern Guam. Due to an apparent lack of standing water available, gray francolins slowly disappeared over the years and the last was seen in August of 1972. The black francolins, however, appeared to slowly prosper in southern Guam, where abundant water sources and thick savannah created an ideal habitat for the birds (Bump, 1970).

Sporadic observations from local farmers, Division of Aquatic & Wildlife Resources (DAWR) conservation officers, and Division wildlife biologists documented the tentative success of the introduction. In February, 1968, a large colony of black francolins was discovered on the Orote Point peninsula and monthly call counts from 12 circular plot censuses were conducted from July, 1968 to March, 1971. Initially up to three calling males were recorded per station, however, this density decreased slowly until by June, 1970, no calling males were heard (DAWR field notes). Increased development by the Navy had apparently forced the birds to relocate.

In November, 1971, efforts were increased to locate and survey viable black francolin colonies and a trapping and banding program was begun (Drahos and Jeffrey, 1977). Data from trapping at Talofofo, Inarajan-Yledigao, and Inarajan-Nagan from November, 1971 through September, 1973 indicated an average of four pairs per ½ mile square with viable populations concentrated in a 6 by 1 mile strip from Talofofo Falls to the Inarajan River (DAWR Field noted). Data also recorded broods from May through August although these birds are known to breed in India from April through September (Kramer, 1973). Although recommendations during this period to facilitate population growth included importation of additional stock from India and the establishment of wildlife food strips to encourage range extension (Drahos and Jeffrey, 1977), these recommendations were never implemented.

From 1974 to 1980, no formal surveys or management practices were conducted by this Division. The population was left to prosper and data collected since the francolin introduction were compiled into an unpublished manuscript, "The status of the black francolin on Guam," by Nick Drahos and Jack Jeffrey.

In March, 1980, plans were developed to systematically survey southern Guam to determine present abundance, density, and distribution of the black francolin and to make recommendations for a possible hunting season as casual observations had indicated good population numbers.

OBJECTIVES

1. To conduct fixed-distance circular plot censuses in southern savannah habitat and determine the abundance, density and distribution of black francolin populations.

2. Based on the census results, make recommendations regarding the feasibility of a trial hunting season for black francolins.

PROCEDURES

Nine transects were located in areas of prime savannah habitat in southern Guam (Figure 1). A total of 366 stations were censused from April through June, 1980, using fixed-distance circular plot censusing methods (Emlen, 1971). Transects were censused both early morning and just before sunset, to determine the most effective censusing time. The number of calling males heard or seen within 200 yds (26 acres) of the observer were recorded, along with any females or broods. The number of calls per minute were also recorded to document calling frequency.

In order to estimate the total population of black francolins on Guam, Approximate densities and amount of suitable habitat had to be derived. Savannah habitat in each transect section was measured with a compensation polar planimeter, using U.S.G.S. maps. The mean number of males per 26 acres observed during the highest count for each transect were used to extrapolate total population numbers, assuming one female per calling male (Nelson, 1968).

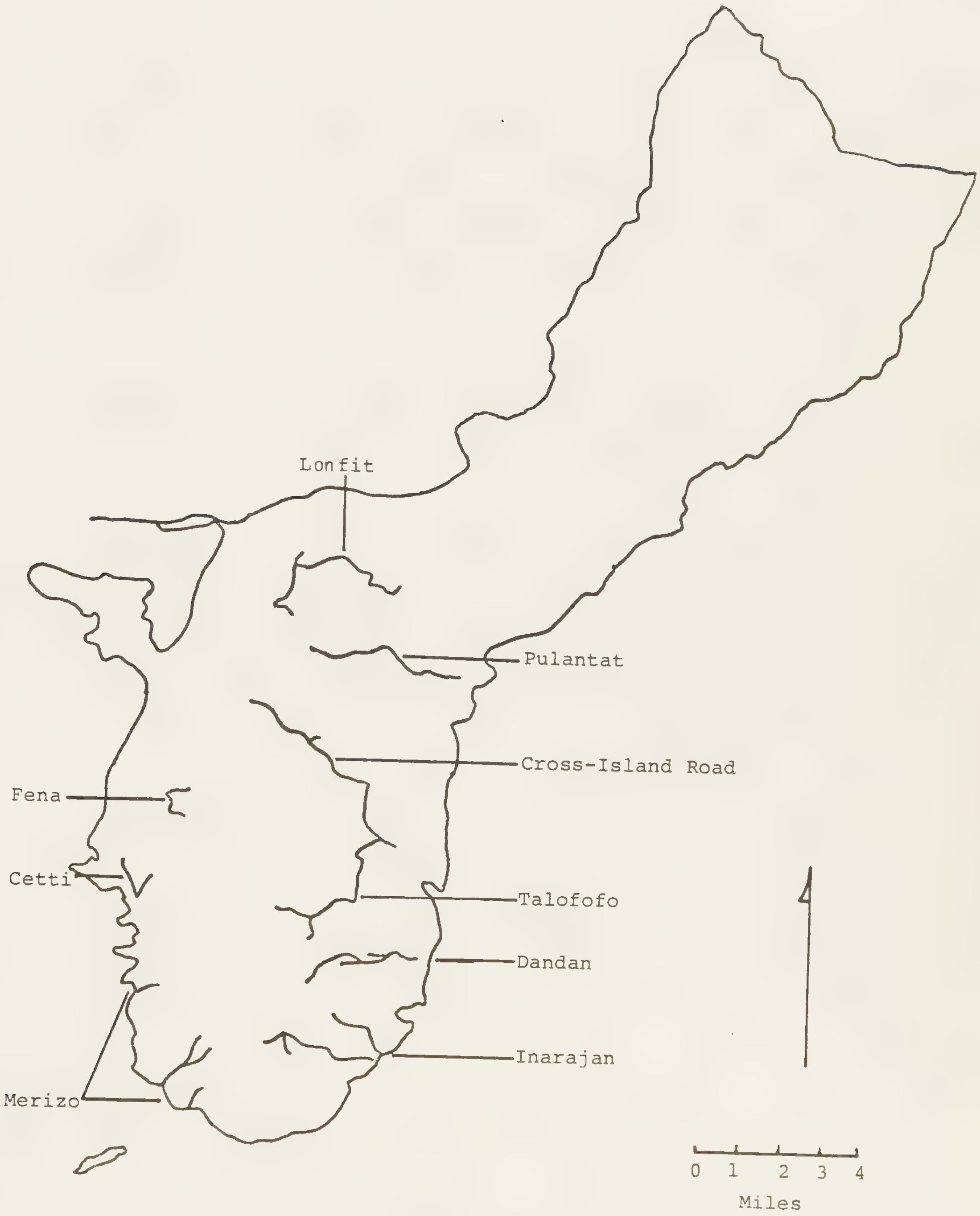
Lonfit
Pulantat
Cross-Island Road
Fena
Cetti
Talofofo
Dandan
Inarajan
Merizo
0 1 2 3 4
Miles

Figure 1 Black Francolin Transect Locations.

After this initial three month censusing period, surveys were concentrated on three widely separately transects: Pulantat, Talafofo, and Merizo (Figure 1). Bi-monthly censusing was continued on these remaining transects to determine seasonal changes in calling frequency.

FINDINGS

Data from the nine transects censused from April through June, 1980 are presented in Table 1. Dandan, the site of original release of the black francolin, consistently showed the highest mean number of birds per count. Density estimates extrapolated from these data would indicate a population in the Dandân area of 18 pairs per ½ mile square, considerably different from the four pairs estimated per ½ mile square in 1973. Black francolin population levels appeared to be consistent from Pulantat south to Merizo, with a smaller population in Lonfit, the extreme north edge of savannah habitat. The savannah area on the Naval Magazine above Fena had an extremely low apparent population level.

In averaging the mean number of birds per station from all nine transects, a density estimate of 9.6 pairs per ½ mile square was obtained. This figure may reasonably reflect the current average density of savannah habitat. It is apparent that the francolin's distribution and abundance has increased substantially since 1973.

Table 2 and Figure 2 show seasonal changes in males calling from April through November. After a relatively consistant number of calls recorded per station in April through August on the three key transect areas, calling frequency dropped noticeably in September and ceased completely during October. However, calls were again recorded in November and in preliminary data for December, although not in the intensity recorded previously. The upsurge in calling in November and December may indicate a second, minor breeding season, a departure from traditional breeding seasons in India. Continuing surveys may substantiate this trend.

Based on the findings of the 1980 francolin surveys, a recommendation was made to establish a limited hunting season in December of 1980. Hunting regulations were established and a public meeting was held on November 5, 1980, resulting in Guam's first black francolin hunt, scheduled for the weekends of December 6 and 7 and December 13 and 14, 1980. Checking stations are to be manned at three key areas in southern Guam to collect data on age and sex ratios. A copy of the hunting regulations accompanies this report in Appendix 1.

RECOMMENDATIONS

1. To continue bi-monthly surveys of black francolins along three transect routes on Guam.

2. To survey all nine transect routes during April through June, 1981 for comparison with 1980 population estimates.

3. Make recommendations on the feasibility of an enlarged hunting season, based on 1981 population estimates.

4. Collect and compile data on age and sex ratios from birds examined at hunter checking stations.

Table 1. Results of censusing black francolins from April through June 1980 with fixed-distance circular plots, showing the mean number of calling males detected within 200 yds. Males per section were estimated using the highest count obtained during the census period. *Birds per section assumes one female per male.

SECTION	LOCATION	ACRES	COUNTS	STATIONS	TOTAL MALES CALLING	$\bar{x}$ MALES STATION	$\bar{x}$ PER STATION (HIGHEST COUNT)	MALES PER SECTION	*BIRDS PER SECTION
1	Lonfit	4276	4	45	24	0.5	0.9	148.0	296.0
2	Cross-Island	6199	5	69	84	1.2	2.3	548.4	1096.8
3	Pulantat	4290	4	23	36	1.6	1.6	264.0	528.0
4	Fena	833	3	15	1	0.1	0.2	6.4	12.8
5	Talofofo	4992	5	78	133	1.7	2.2	422.4	844.8
6	Dandan	3144	3	21	40	1.9	3.0	362.8	725.6
7	Inarajan	1929	4	55	96	1.7	2.9	215.2	430.4
8	Merizo	4444	4	44	67	1.5	1.6	273.5	547.0
9	Cetti	3751	4	16	8	0.5	1.0	144.3	288.6
TOTAL		33589	36	366	489			2385.0	4770.0

Table 2. Results of censusing black francolins over an eight month period with fixed-distance circular plots . Shows mean number of calling males detected from three target transect areas. No data was collected for the month of July.

	April			May			June			July			August			September			October			November		
	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo	Pulantat	Talofofo	Merizo
Counts	1	1	1	2	2	1	1	1	2				2	2	1	3	1	3	2	1	2	2	2	2
Stations	4	9	11	8	34	11	11	17	22				14	24	11	30	4	33	15	11	22	19	30	22
Calling males	6	10	13	12	57	18	18	27	36				9	24	19	3	0	34	0	0	0	7	50	15
Mean calling males per station	1.5	1.1	1.2	1.5	1.7	1.6	1.6	1.6	1.6				0.6	1.0	1.7	0.1	0.0	1.0	0.0	0.0	0.0	0.4	1.7	0.7

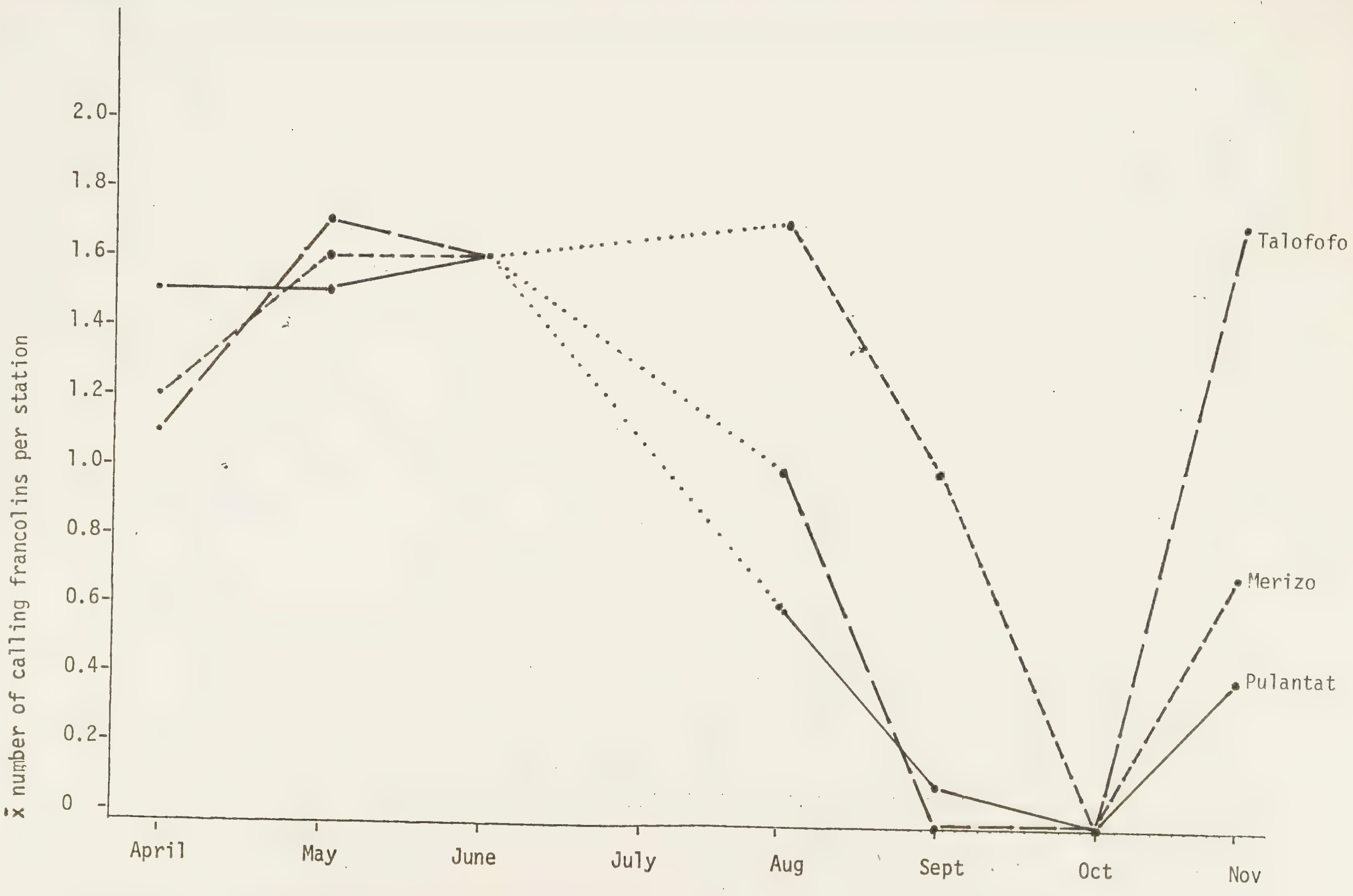

Figure 2 Calling frequency of male black francolins over an 8 month period, from 3 transect areas on Guam. No counts were conducted during July.

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Report Prepared by: Anne F. Maben and Robert Cruz

APPENDIX I

SPECIAL BLACK FRANCOLIN HUNTING REGULATIONS

SPECIAL BLACK FRANCOLIN HUNTING REGULATIONS

Pursuant to the authority vested in the Director of Agriculture by Sections 12007 and 12321, Government Code of Guam, the following regulations relating to the harvest of Black Francolins are hereby promulgated:

1. HUNTING SEASON: It shall be legal to hunt the Black Francolin, an introduced game bird, on the following dates only: December 6 & 7 and December 13 & 14, 1980.
2. BAG LIMIT: 2 birds per day
   SEASON LIMIT: 8 birds
   Both male and female Francolins may be taken.
3. LOCATION: It shall be legal to hunt Black Francolins in areas south of the following boundary: Beginning at the mouth of Atantano River and proceeding upstream to the Paulana River, thence proceeding upstream along the Paulana River to Mount Tenjo, thence proceeding along the ridgeline to Mount Chachao, thence from Mount Chachao to the headwaters of the Lonfit River, thence downstream along the Lonfit River to the Pago River, thence downstream along the Pago River to its mouth. Birds located north of this boundary shall not be hunted. Prior to hunting on private property, permission of the landowner shall be obtained.
4. LEGAL SHOOTING TIME: It shall be legal to hunt Black Francolins in season from one-half hour before sunrise to one-half hour after sunset.

5. GENERAL HUNTING REGULATIONS: Pursuant to Department of Agriculture Regulation No. 41, all general hunting rules and regulations will apply to the taking of Black Francolins. In accordance with these rules, hunters shall possess a valid 1980 hunting license and use shot no larger than No. 6.

6. CHECKING STATIONS: Hunters shall bring their birds daily to checking stations manned by Division of Aquatic & Wildlife personnel, for purposes of scientific data collection. After brief examination, birds shall be immediately released to the hunter. Checking stations will be located at the following areas:

Dandan: On the road to the NASA tracking station.
Cross-Island Road: Adjacent to the Windward Hills Golf Course.
Merizo: On the main road, just east of the town proper.

Spot checks in hunting areas may be performed by DAWR Conservation Officers throughout the season. Stations shall be manned from 9:00 a.m. to 12:00 noon and from 4:00 p.m. to 7:00 p.m. of each official hunting day.

Dated this SEVENTH day of NOVEMBER, 1980

ANTONIO S. QUITUGUA
Director of Agriculture

Approved as to form:

Jack Avery
JACK AVERY
Attorney General (Acting)

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-3 Non-Game Mammals
Study 1 The Status and Ecology of
Wild Asiatic Water Buffalo
(Carabao) on Guam

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-3
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Carabao on Guam

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

The population status, adult to calf ratio and herd sizes of wild Asiatic water buffalo (*Bubalis bubalis*) on the U.S. Naval Magazine, Guam are reported. Night spotlight counts conducted from 1964 to 1980 are analyzed and an increasing population trend over this period is noted. Some ecological observations, such as mortality factors and habitat damage, are reported and recommendations are made for management of this species on Guam.

BACKGROUND

The Asiatic water buffalo (*Bubalis bubalis*), or carabao (Figure 1), was introduced to Guam in the 1600's from the Philippines to be used as a beast of burden (Gibson 1977). Prior to World War II, a total of about 2,000 head existed on several private ranches in the southern hills of Guam in an area bounded by the villages of Agat, Inarajan, Merizo, and Talofofo (Gibson 1977). During the Japanese occupation many of these herds were decimated for food, and some were turned loose to wander freely over the more remote, interior regions. Since that time some of these feral animals have re-adapted to the wild state and have established a viable breeding population on a large land reserve presently owned by the U.S. Navy (Leeke 1977).

The Division of Aquatic and Wildlife Resources of Guam has been conducting a study of the biology of the Guam deer (*Cervus unicolor mariannus*) since 1961 (Wheeler 1979). During that study, it was possible to collect some population and composition data on water buffalo because some deer counts were conducted in water buffalo habitat. Wild Asiatic water buffalo on Guam are found primarily in areas of ravine or swamp forest interspersed with *Miscanthus* grasslands on volcanic soil. Fosberg (1960) and Stone (1970) have described these vegetation types in more detail. The non-private land areas occupied includes the headwaters of the Bubulao river (Figure 2). Population counts were conducted on the Naval Magazine (1025 ha), a storage facility for explosives located in south-central Guam. Part of Fena Reservoir (71 ha), a large man-made lake, is located on the Magazine. Access is restricted to military personnel and government employees on official business. Although hunting is not permitted on this property, the facility is not fenced and incidents of illegal hunting are common. Most of this acitvity is directed towards hunting deer at night with spotlights.

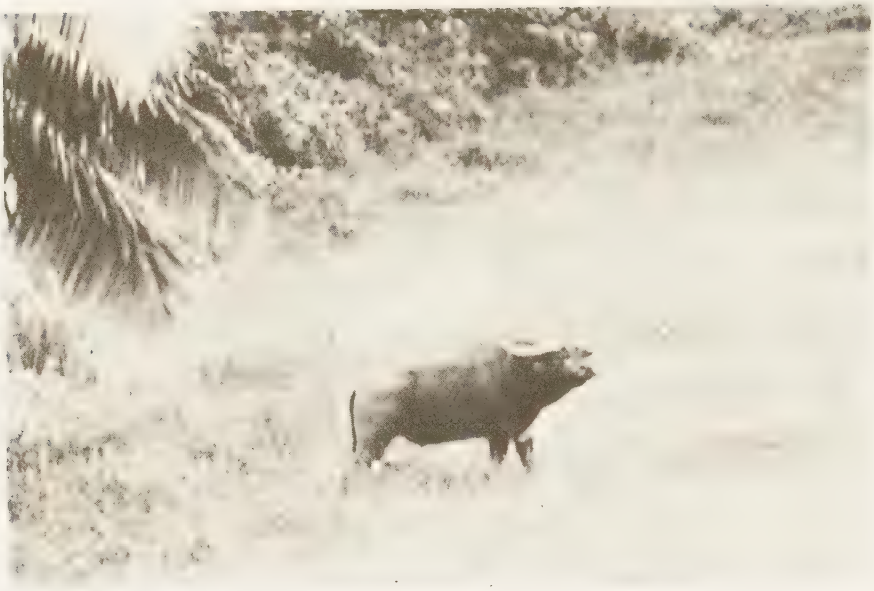

Figure 1. A wild Asiatic Water Buffalo (Bubalis bubalis), or Carabao, on the U. S. Naval Magazine, Guam.

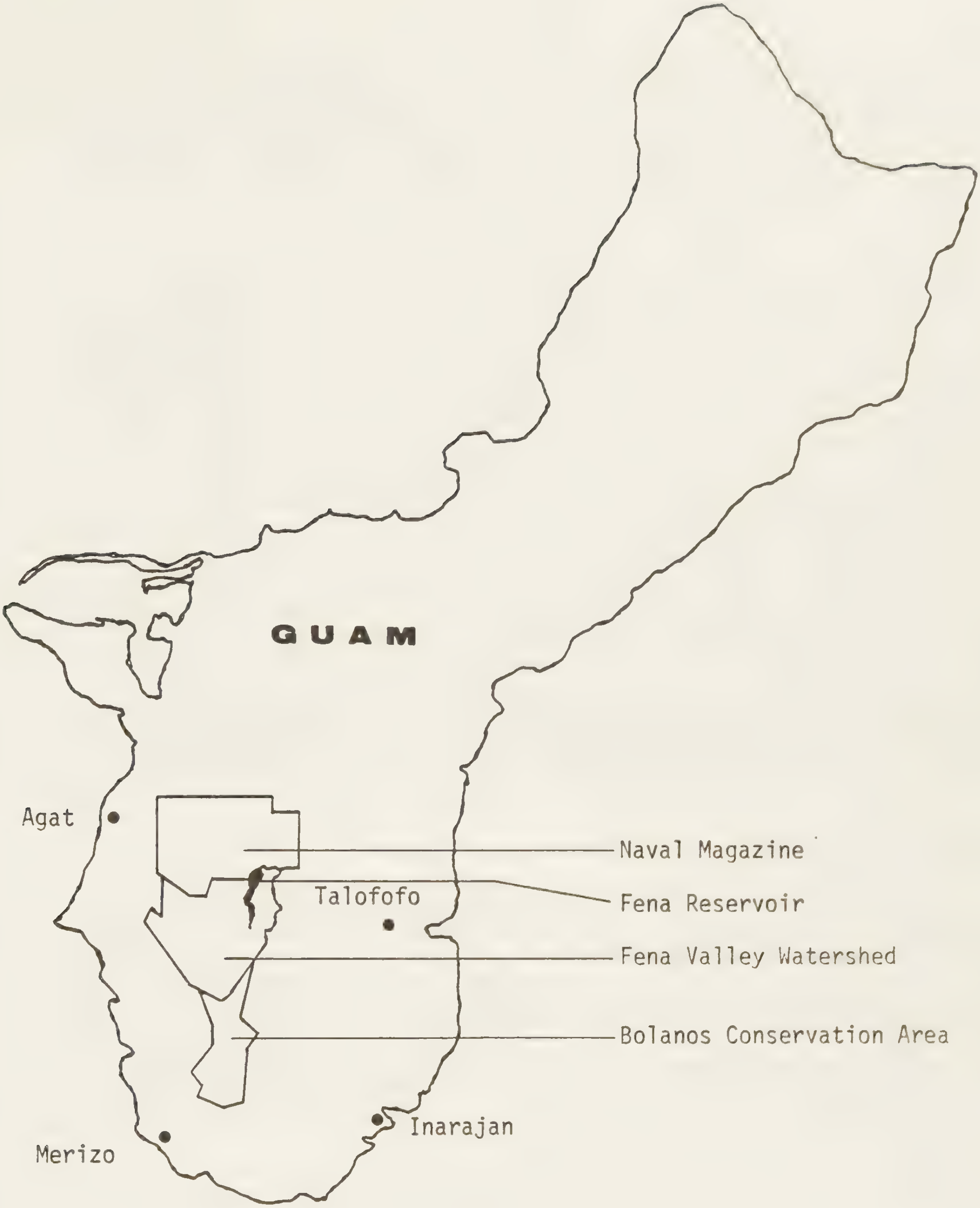
GUAM
Agat
Naval Magazine
Talofofo
Fena Reservoir
Fena Valley Watershed
Bolanos Conservation Area
Inarajan
Merizo

Figure 2. Location map of water buffalo habitat on Guam.

OBJECTIVE

To determine numbers and distribution of wild or free-ranging carabao on Guam. Secondary objectives are: To report the population trend of these wild buffalo on Guam, to report the adult to young ratio over the period of study (1964-1978), and to formulate future research recommendations that will result in the wise management of this wildlife resource.

PROCEDURES

Night spotlight counts were conducted monthly on the Naval Magazine to assess the population status of deer. During some of these counts, records were kept of the number of water buffalo sighted, and in some cases the sex and age group (adult or calf) were recorded. A spotlight count required two persons: a driver and a spotter. The route was predetermined and the count was initiated about one hour after dusk. The driver drove slowly (about 8 kph) while the spotter, seated on the roof of the vehicle, carefully scanned the surrounding area with a spotlight, looking for animals or eyeshine. If animals or eyeshine were observed the spotter tapped the roof of the vehicle, whereupon the driver stopped the vehicle and the spotter attempted to identify the animals with the aid of binoculars. The elapsed time, total mileage, weather conditions were recorded for each count. Spotlight counts were conducted monthly through fiscal year 1969; however, since the counts were primarily designed for gathering data on deer numbers and herd composition, water buffalo sightings were not always recorded. Water buffalo sightings were recorded during eight counts conducted between September 1966 and November 1967, and during eight counts conducted between March 1968 and December 1972. Starting in fiscal year 1974, water buffalo sightings were recorded during each of the monthly night spotlight counts.

RESULTS AND DISCUSSION

Since there was variation in mileage for spotlight counts, all count data were standardized by determining the number of animals sighted per 16 km traveled (Figure 3). The mean and maximum number of buffalo sighted per time period were determined. Both parameters suggest an increasing population over the period of study. Coincident with this increase has been an increasing ratio of calves to adults (Table 1). Assuming in-migration and out-migration to be equal, these age group data, although somewhat limited, suggest that either a greater portion of the population is reproducing or a greater percentage of the calf cohort is surviving. In either case, the trend is further indicative of an increasing population.

Asiatic water buffalo are gregarious animals, assembling in herds of various sizes (Walker 1968). The size of herds on the Naval Magazine was quite variable, with 26 animals being the largest herd observed. The most common groupsize was 1-5 animals (Table 2), but the greatest number of individuals was seen in groups of 6-10.

Three cases of mortalities were reported to Division biologists by Naval security personnel during the period of study. All three cases were the result of illegal hunting activities, and it is likely that this cause is a major mortality factor. With the possible exception of feral dogs, potential predators of water buffalo are absent from the island. Feral

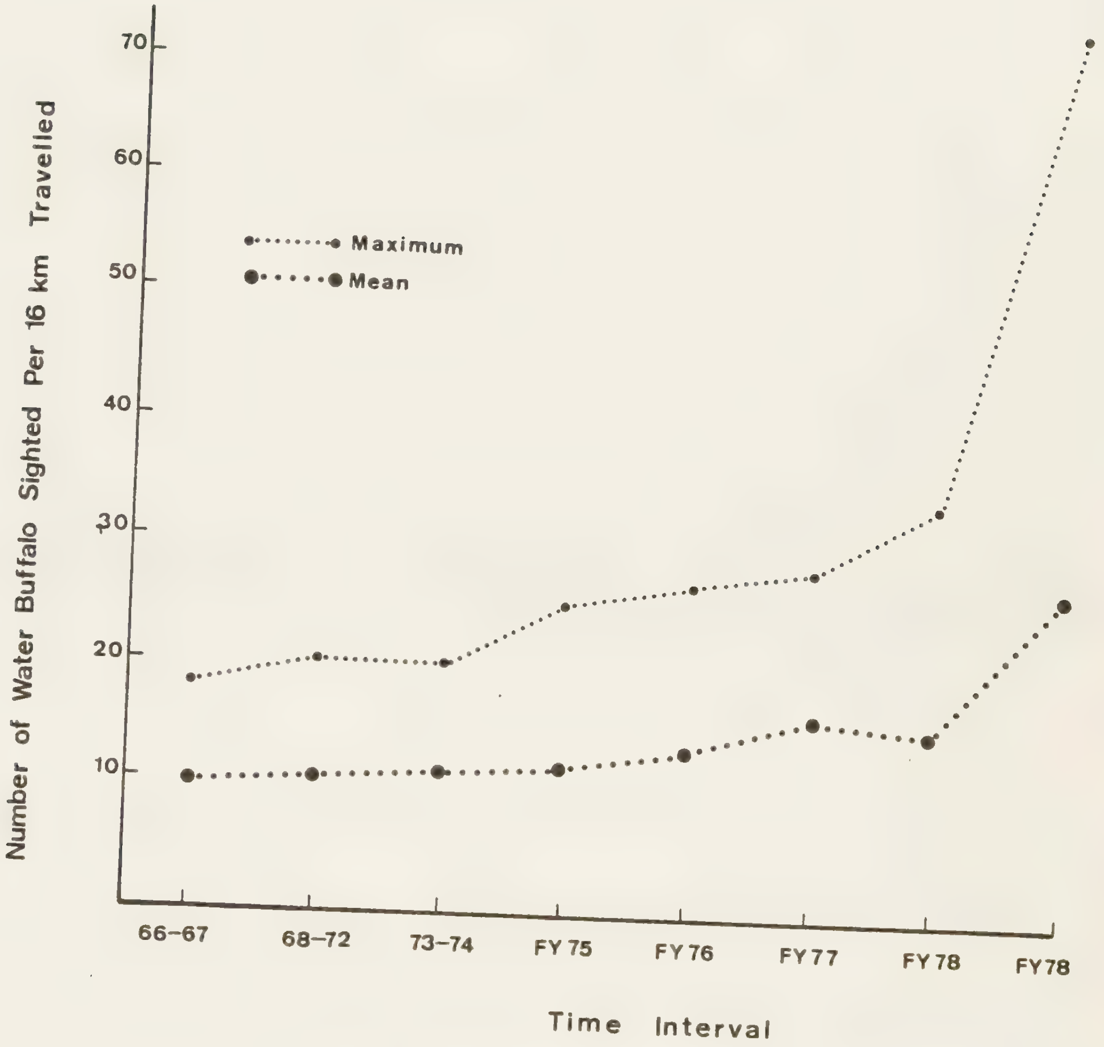

Figure 3. Population trend of water buffalo on the Naval Magazine.

Table 1. Ratio of calves to adults of wild water buffalo on the Naval Magazine.

Time Period	Adults (No. Classed)	Calves (No. Classed)	Ratio of Calves to Adults
1966 - 1969	53	6	0.11 : 1
1971 - 1974	14	2	0.14 : 1
1975 - 1978	343	58	0.17 : 1

Table 2. Social grouping of wild water buffalo on the Naval Magazine.

Group Size (No. of Animals)	No. Groups	Total No. Animals In Group Size	Percent of Animals In Group Size*
1 - 5	83	201	17.7%
6 - 10	27	301	26.5%
11 - 15	18	236	20.8%
16 - 20	15	259	22.8%
21 - 26	5	140	12.3%

*Total number of animals in group category X 100, divided by the total number of animals in all group categories.

dogs are occasionally sighted on the Naval Magazine, however, it is the policy of security personnel to dispatch these animals when possible. In short, causes of mortality are relatively few and cases of fatalities among the water buffalo of the Naval Magazine are very infrequent.

Signs of water buffalo presence may be seen throughout the Naval Magazine. Droppings, mud wallows, tracks and trails may be seen in most areas. Some areas are so heavily traversed that slumping and erosion scars have developed. These developments, coupled with an increasing population trend, are indicative of the need for more detailed study of the water buffalo on Guam.

MANAGEMENT RECOMMENDATIONS

The ultimate goal of a management program is a healthy population, compatible with the available food and habitat resources. Achievement of this goal will require a detailed study of the ecology and behavior of wild water buffalo on Guam. In addition to monitoring the population on the Magazine by conducting sex, age and group counts, and determining the abundance of water buffalo in neighboring areas, future research efforts should address the topics of movement patterns, home range, food habits, reproductive biology, optimum density, habitat quality and quantity, and behavior.

With the absence of predators and prohibition of hunting or capture of the wild water buffalo on the Naval Magazine, coupled with an increasing population trend, it is likely that some population control measures may be required before all the requisite ecological data are collected. Signs of some habitat damage are already present in the form of erosion scars. Immediate efforts should be directed towards determining whether or not water buffalo are becoming more abundant on the Naval Magazine than the available habitat can support. It may be necessary to translocate some animals to less heavily disturbed water buffalo habitat. With timely action and a long term research program, the ultimate goal management may be realized.

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Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-4 Non-Game Birds
Study 1 Survey and Inventory of
Non-Game Birds

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Shorebirds on Guam

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Bi-monthly censuses were conducted on two coastal transects and 23 species from the families Ardeidae, Haematopodidae, Charardriidae, Scolopacidae and Laridae were recorded. Two new migrant shorebirds previously unreported from Guam were recorded, as well as an unreported duck and tern. Periodic surveys of grassland areas investigated local movement patterns among shorebirds.

BACKGROUND

Migratory shorebirds make up a significant proportion of non-game birds present on Guam. Until recently, little work had been done to define species composition and seasonality on Guam. Previous work consisted mainly of intermittent sight records, collection for museum skins and annecdotal observations.

In order to systematically quantify Guam's shorebirds, a survey consisting of 100 counts from two coastal transects was conducted by J. Mark Jenkins, former Wildlife Biologist, Division of Aquatic & Wildlife Resources. Valuable baseline data obtained from this survey were compiled in the manuscript "Seasonality and Relative Abundance of Guam Shorebirds" (Jenkins, 1980).

To further document this studies conclusions and compile observations on feeding patterns and species composition, shorebird census continued to be conducted both in coastal areas and on grasslands.

OBJECTIVES

I. To continue to inventory shorebirds on Guam and monitor their periodic occurrence.

II. To collect observations on feeding behavior, species composition and movement patterns.

PROCEDURES

1. Bi-monthly censuses were conducted along the shoreline of Agana Bay (Alupang Cove) and along the shoreline of Togcha Beach (Figure 1), from March through December, 1980. Data were not obtained during January and February of 1980 due to a lack of personnel. Species numbers and composition of all migrant birds were recorded along with pertinent behavorial observations.

2. Periodic surveys of grassland areas including golf courses and airfields were conducted, to better understand local movement patterns and document any new species unrecorded for Guam.

FINDINGS

Data from the shorebird censuses conducted during 1978-1980 are presented in Tables 1-4, expressed as the number of birds of each species observed per 100 kilometers of travel each month. Transect censuses were not conducted in 1979. In order to illustrate the population stability of migrant shorebirds on Guam and point out any significant changes, combined transect data from 1978 were compared with combined transect data from 1980 (Table 5). This table presents the mean number of birds seen per 100 kilometers of travel as well as the standard deviation and coefficient of variation. The Mann-Whitney U-Test (Sokal and Rohlf, 1969) was used to test significant differences between the means of 1978 and 1980. Species populations that differ significantly between years are indicated with an asterisk.

These tables indicate a high degree of stability between years of migrant shorebird populations present on Guam. Black-headed gulls and common greenshanks show a significant decrease in population, however, the numbers of birds observed are so small that no long-term conclusions can be drawn. Black-bellied plovers showed a significant increase and may reflect an actual extension of this bird's wintering range or simply a higher proportion of individuals aggregating with migrating Pacific golden plovers. A ratio of approximately 1 black-bellied plover to every 20 Pacific golden plovers was observed on the Navy Golf Course at the height of the fall migration in 1980.

In comparing windward (Togcha) shorelines to leeward (Agana Bay) shorelines, data indicate higher populations of all species on the leeward transect. The more protected, sandy reef flats of western Guam appear to offer greater feeding opportunities to high populations of migrants, although the high algal ridge at Togcha Beach makes it difficult to observe birds feeding at the reef's edge. Surveys of Togcha were conducted mainly at high tide, where large waves forced birds to forage close to the water's edge.

Behavorial and feeding observation show that as a rule, species tended to aggregate with members of similar sub-families or tribes. Black-bellied and golden plovers fed closely together in the mid-littoral zone, while dotterels and little ringed plovers tended to occur singlely with no close association. Whimbrels and curlews foraged together in the deeper water exclusively for crabs. While Jenkins treated all _Numenius_ species as one

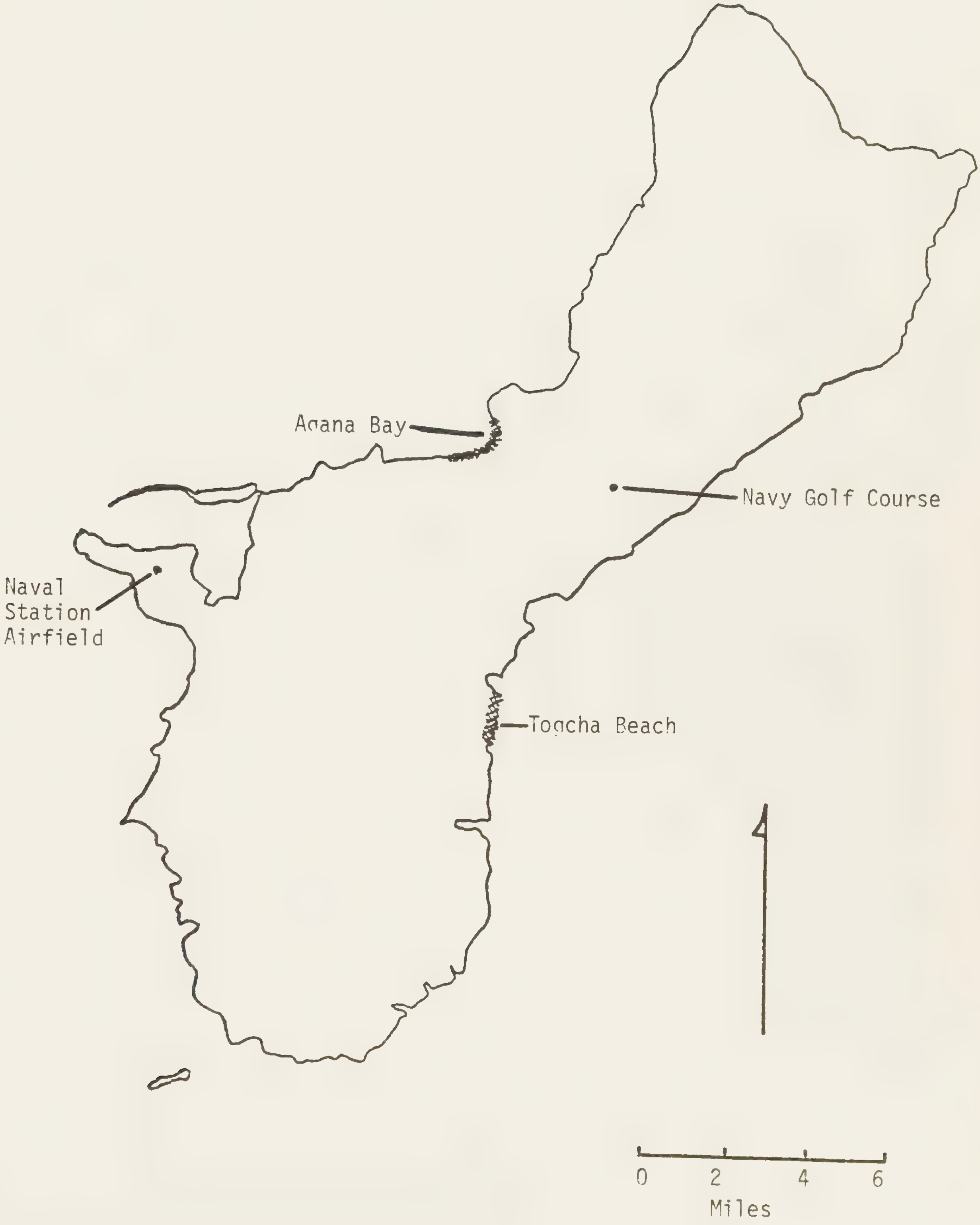
Agana Bay
Navy Golf Course
Naval Station Airfield
Togcha Beach
0
2
4
6
Miles

Figure 1. Shorebird transects and major shorebird grassland areas on Guam.

Table 1. Number of birds per 100 kilometers of travel observed each month during the Toqcha Beach shorebird surveys during March through December 1978. Shows mean number of birds per hundred miles of travel, standard deviation (σ) and coefficient of variation (CV).

SPECIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	$\overline{X}$/Count	$\overline{X}$/100 Km	σ	CV
Reef Heron			105.8	115.6	41.6	7.7	48.1	46.2	48.1	48.1	57.7	76.9	62	1.4	59.6	31.9	53.6
European Widgeon																	
European Oyster catcher																	
Black-bellied Plover																	
Golden Plover			1096.2	1924	20.8	7.7	144.2	307.7	923.1	1461.5	1009.6	2007.7	971	22.6	769.9	807.8	104.9
Little Ringed Plover																	
Mongolian Dotterel			346.2	176.8	62.4	0	0	38.5	153.8	57.7	182.7	146.2	124	2.9	116.4	106.8	91.7
Greater Sandplover																	
Ruddy Turnstone			596.2	405.6	72.8	0	230.8	269.2	625.0	346.2	817.3	369.2	401	9.3	373.2	252.3	67.6
Whimbrel & Curlews			57.7	31.2	41.6	15.4	0	123.1	403.8	144.2	125.0	100.0	121	2.8	104.2	116.6	111.9
Black-tailed Godwit																	
Bar-tailed Godwit			0	0	0	0	0	0	0	0	28.8	30.8	7	0.2	6.0	12.6	211.0
Common Greenshank																	
Wood Sandpiper																	
Common Sandpiper			0	0	0	0	0	0	57.7	0	9.6	7.7	9	0.2	7.5	18.0	210.0
Sanderling			0	0	0	0	0	0	0	0	0	7.7	1	0.02	0.8	2.4	316.2
Sharp-tailed Sandpiper																	
Long-toed Stint																	
Rufous-necked Stint																	
Black-headed Gull																	
Little Tern																	
Kilometers			10.4	10.4	10.4	13	10.4	13	10.4	10.4	10.4	13	111.8	2.6			
Counts			4	4	4	5	4	5	4	4	4	5	43				

Table 2. Number of birds per 100 kilometers of travel observed each month during the Togcha Beach shorebird surveys, during March through December 1980. Shows mean number of birds per hundred miles of travel, standard deviation (σ) and coefficient of variation (CV).

SPECIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	$\overline{X}$/Count	$\overline{X}$/100 Km	σ	CV
Reef Heron			19.2	38.5	28.8	9.6	38.5	28.8	9.6	48.1	38.5	48.1	32	1.6	30.8	14.2	46.2
European Widgeon																	
European Oyster catcher																	
Black-bellied Plover			0	4.6	0	0	0	0	28.8	0	28.8	9.6	8	0.4	7.7	11.8	153.6
Golden Plover			711.5	413.5	28.8	57.7	182.7	57.7	653.8	1644.2	980.8	788.5	574	28.7	551.9	514.9	93.3
Little Ringed Plover																	
Mongolian Dotterel			115.4	76.9	28.8	0	9.6	96.2	86.5	76.9	250.0	96.2	87	4.4	83.7	70.4	84.1
Greater Sandplover																	
Ruddy Turnstone			144.2	586.5	57.7	0	211.5	278.8	365.4	519.2	192.3	67.3	252	12.6	242.3	196.7	81.2
Whimbrel			38.5	19.2	0	9.6	0	48.1	28.8	19.2	0	19.2	19	1.0			
Bristle-thighed Curlew			0	0	0	0	0	0	134.6	201.9	9.6	9.6	37	1.9			
Black-tailed Godwit																	
Bar-tailed Godwit			0	0	0	0	0	0	19.2	0	19.2	105.8	4	0.2	14.4	33.1	229.4
Common Greenshank																	
Wood Sandpiper			0	0	0	0	0	0	0	38.5	19.2	0	6	0.3	5.8	13.0	225.1
Common Sandpiper			0	0	0	0	0	0	0	0	9.6	0	1	0.1	1.0	3.0	316.2
Sanderling			0	0	0	0	0	19.2	57.7	57.7	9.6	19.2	17	0.9	16.3	23.1	141.6
Sharp-tailed Sandpiper			0	0	0	0	0	9.6	9.6	0	0	0	1	0.1	1.9	4.0	210.8
Long-toed Stint																	
Rufous-necked Stint			0	0	0	0	0	19.2	211.5	173.1	9.6	0	54	2.7	41.3	80.3	194.3
Black-headed Gull																	
Little Tern			0	0	0	0	0	0	0	0	9.6	28.8	4	0.2	3.8	9.3	241.5
Kilometers			10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	104.0	5.2			
Counts			2	2	2	2	2	2	2	2	2	2	20				

Table 3. Number of birds per 100 kilometers of travel observed each month during the Agana Bay shorebird surveys, during March through December 1978. Shows mean number of birds per hundred miles of travel, standard deviation (σ), and coefficient of variation (CV).

SPECIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	$\overline{X}$/Count	$\overline{X}$/100 Km	σ	CV
Reef Heron			73.5	44.1	88.2	70.6	58.8	29.4	58.8	117.6	58.8	14.7	45	1.1	71.5	28.5	47.3
European Widgeon																	
European Oyster Catcher																	
Black-bellied Plover			0	0	0	0	0	0	0	0	0	14.7	1	0.02	1.5	4.6	321.0
Golden Plover			5779.4	2205.9	147.1	82.4	717.6	897.1	1397.1	4000.0	1176.4	2308.8	1,306	30.4	1871.3	1803.3	96.4
Little Ringed Plover			0	0	0	0	0	0	0	0	0	29.4	2	0.1			
Mongolian Dotterel			367.6	220.6	102.9	35.3	35.3	73.5	117.6	73.5	376.5	279.4	120	2.8	168.2	132.6	78.9
Greater Sandplover			0	0	0	0	0	0	44.1	0	0	0	3	0.1			
Ruddy Turnstone			2073.5	1132.4	338.2	58.8	176.5	250.0	323.5	617.6	164.7	661.8	401	9.3	579.7	613.2	105.8
Whimbrel & Curlews			794.1	897.1	1058.8	1105.9	1352.9	617.6	558.8	647.1	717.6	794.1	635	14.8	854.4	251.2	29.4
Black-tailed Godwit			0	58.8	88.2	117.6	70.6	14.7	0	0	0	0	27	0.6	35.0	44.8	127.9
Bar-tailed Godwit			0	0	0	0	11.8	14.7	88.2	14.7	105.9	102.9	25	0.6	26.5	5.6	212.4
Common Greenshank			58.8	14.7	14.7	0	0	0	0	0	0	0	6	0.1	8.8	18.6	210.8
Wood Sandpiper																	
Common Sandpiper			0	0	0	0	70.6	88.2	132.4	29.4	70.6	147.0	39	0.9	53.8	56.6	105.1
Sanderling			0	0	0	0	0	0	29.4	102.9	176.5	44.1	27	0.6	35.3	59.7	169.2
Sharp-tailed Sandpiper			0	0	0	0	35.3	0	44.1	0	0	0	6	0.1	7.9	16.9	212.4
Long-toed Stint			0	0	0	0	0	0	0	14.7	47.1	44.1	8	0.2			
Rufous-necked Stint			88.2	0	0	0	0	0	0	0	0	0	6	0.1	8.8	27.9	316.2
Black-headed Gull																	
Little Tern																	
Kilometers			6.8	6.8	6.8	8.5	8.5	6.8	6.8	6.8	8.5	6.8	73.1	1.7			
Counts			4	4	4	5	5	4	4	4	5	4	43				

Table 4. Number of birds per 100 kilometers of travel observed each month during the Agana Bay shorebird surveys, during March through December 1980. Shows mean number of birds per hundred miles of travel, standard deviation (σ) and coefficient of variation (CV).

SPECIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	$\overline{X}$/Count	$\overline{X}$/100 Km	σ	CV
Reef Heron			147.1	117.6	0	58.8	0	29.4	19.6	0	58.8	58.8	17	0.8	49.0	50.6	103.3
European Widgeon			176.4	0	0	0	0	0	0	0	0	0	6	0.3	17.6	55.8	316.2
European Oyster catcher			58.8	58.8	58.8	58.8	58.8	58.8	19.6	58.8	58.8	58.8	19	0.9	54.9	12.4	22.6
Black-bellied Plover			58.8	0	0	29.4	29.4	29.4	19.6	0	58.2	205.9	16	0.8	46.1	62.7	136.1
Golden Plover			352.9	1302.4	352.9	882.4	1000.0	4176.5	4843.1	3411.8	1882.3	2529.4	1237	58.9	3396.1	3670.4	108.1
Little Ringed Plover			58.8	58.8	58.8	0	0	0	58.8	58.8	58.8	88.2	16	0.8	44.1	31.8	72.0
Mongolian Dotterel			264.7	382.4	294.1	0	0	117.6	78.4	88.2	794.1	235.3	78	3.7	225.5	237.6	105.4
Greater Sandplover			58.8	58.8	0	0	0	0	19.6	0	0	0	5	0.2	13.7	24.5	178.8
Ruddy Turnstone			323.5	1500	470.6	647.1	352.9	588.2	843.1	617.6	294.1	176.5	212	10.1	581.4	379.4	65.3
Whimbrel			294.1	794.1	352.9	558.9	676.5	647.1	333.3	588.2	264.7	264.7	168	8.0	477.5	196.6	41.2
Bristle-thighed Curlew			0	0	0	0	0	29.4	862.7	58.8	29.4	235.3	56	2.7	121.5	270.2	222.4
Black-tailed Godwit			58.8	58.8	0	0	0	0	0	29.4	0	0	5	0.2	14.7	25.0	170.0
Bar-tailed Godwit			58.8	58.8	0	0	0	0	0	0	0	0	4	0.2	11.8	24.8	210.8
Common Greenshank			0	0	0	0	0	0	0	0	0	29.4	1	0.1	2.9	9.3	316.2
Wood Sandpiper																	
Common Sandpiper			29.4	0	0	0	88.2	88.2	0	176.5	88.2	88.2	19	0.9	55.9	59.6	106.6
Sanderling			0	0	264.7	294.1	147.1	29.4	19.6	0	0	29.4	27	1.3	78.4	114.9	146.5
Sharp-tailed Sandpiper			0	0	0	0	0	0	0	0	29.4	0	1	0.1	7.9	9.3	316.2
Long-toed Stint																	
Rufous-necked Stint			29.4	0	29.4	0	0	0	0	29.4	529.4	970.6	54	2.6	158.8	328.7	207.0
Black-headed Gull			29.4	0	0	0	0	0	0	0	0	0	1	0.1	2.9	9.3	316.2
Little Tern			0	0	0	0	0	0	0	117.6	0	0	4	0.2	11.8	37.2	316.2
Kilometers			3.4	3.4	3.4	3.4	3.4	3.4	5.1	3.4	3.4	3.4	35.7	1.7			
Counts			2	2	2	2	2	2	3	2	2	2	21				

Table 5. Results of shorebird counts conducted at Togcha Beach and Agana Bay from March through December 1978 and 1980, showing the mean number of birds seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

	1978			1980		
SPECIES	$\overline{X}$ per 100 km.	σ	CV	$\overline{X}$ per 100 km.	σ	CV
Reef Heron	121.0	36.7	30.3	79.8	50.3	63.1
European Widgeon				17.6	55.8	316.2
European Oystercatcher				54.9	12.4	22.6
Black-bellied Plover	1.5	4.6	321.0	53.8*	66.4	123.6
Golden Plover	2761.4	2331.6	84.4	394.8	3717.8	42.0
Little Ringed Plover	2.9	9.3	316.2	44.1	31.8	72.0
Mongolian Dotterel	284.7	232.0	81.5	308.2	300.0	97.4
Greater Sandplover	44	13.9	316.2	13.7	24.5	178.8
Ruddy Turnstone	952.9	736.0	77.2	823.7	538.0	65.3
Black-tailed Godwit	35.0	44.8	127.9	14.7	25.0	170.0
Bar-tailed Godwit	39.8	56.3	141.5	26.2	36.5	139.4
Common Greenshank	8.8	18.6	210.8	2.9*	9.3	316.2
Wood Sandpiper				5.8	13.0	225.1
Common Sandpiper	61.3	68.7	112.1	56.8	60.2	105.9
Sanderling	36.1	59.9	166.1	94.8	106.7	112.6
Sharp-tailed Sandpiper	7.9	16.9	212.4	4.9	9.5	195.5
Long-toed Sandpiper	10.6	19.0	179.1			
Rufous-necked Stint				200.2	319.7	159.7
Black-headed Gull	8.8	27.9	316.2	2.9*	9.3	316.2
Little Tern				15.6	37.0	237.1
Counts	n=86			n=41		
Kilometers	184.9			139.7		

for the purpose of data evaluation, total numbers of birds observed in 1980 revealed 66.5% to be whimbrels and 33.5% to be bristle-thighed curlews. The sole European oystercatcher on island (a new record for Micronesia) exploited clams and polychaete worms on sand bars and associated closely with whimbrels. Both species of godwits associated only with each other in the deeper waters. The small numbers of Tringeds found on island probed deeply for small invertebrates in the mid-littoral zone or were found searching for insects in the grasslands. Two upland plovers, a new record for Micronesia, were observed feeding on insects among several hundred folden plovers at the Naval Golf Course. Tattlers were found exclusively at the waters edge, particularly on jagged substrate. The two species are only able to be confidently separated while in breeding plumage (king and Dickinson, 1975) and data show that 83.5% of breeding-plumaged birds were gray-tailed tattlers while 16.5% were wandering tattlers. Reef herons, fishing in small numbers on most reef areas on Guam, were observed in a ration of 77.6% dark plumaged to 22.4% white plumaged birds. This proportion is not significantly different ($P>.05$) from that found in 1978. The high littoral zone was utilized by ruddy turnstones who upended coral rubble while foraging and Calidris species, who probed systematically in small flocks for food. European widgeons, a new record for Guam and little terns, also a new record, foraged in the sub-littoral zone offshore.

During high tide, main foraging zones on the lee side of Guam were covered by 6 inches to 1½ feet of water, forcing the birds to other areas. Grasslands such as golf courses, antennae fields, and abandoned airstrips contained a high proportion of migrant shorebirds during high tide, while coastal transects surveyed as little as ½ hour earlier showed comparatively few birds. Key individuals of unmistakable identificationsuch as the European oystercatcher and a one-legged dotterel were present on 95.3% of the transects at Agana Bay. These same individuals were observed to fly 9.3 miles to rest at the Naval Station airfield nightly and at high tide. These data indicate that many birds may make a daily shift to grasslands or opposite shores to maximize foraging time.

Table 7, 8, and 9 in the W-4-1-3 (Native Birds) Job Progress Report show a significant drop ($P<.05$) in golden plovers observed along the 1980 Northwest Field roadside counts, a significant increase in the number of plovers observed during the North-Central counts, and no change between years on the North route. In combining all three roadside counts in 1980, however, there is no significant difference ($P<.05$) in the overall number of plovers observed on roadside counts. Comparing the mean number of plovers per 100 km on both 1980 beach transects with the mean number of plovers per 100 miles observed along the North-Central route (containing the most grasslands) indicates that golden plover populations are 4 times greater in beach areas.

RECOMMENDATIONS

I. Continue bi-monthly shorebird censuses at two beach locations on Guam.

II. Conduct bi-monthly shorebird censuses at one grassland area on Guam.

III. Continue to collect observations on movement and activity patterns of shorebirds on Guam.

IV. Complete a manuscript detailing new shorebird records for Guam.

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Report prepared by: Anne F. Maben

Reef heron

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-18
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Survey and Inventory of Seabirds on Guam

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Surveys of seabirds were conducted to ascertain present breeding sites on Guam and to inventory seabird abundance and frequency of occurrence in pelagic feeding areas around Guam.

BACKGROUND

Periodic surveys of resident seabird colonies on Guam have been conducted since the early 1960's. Due to a scarcity of undisturbed off-shore islets and suitable sand spits, Guam historically has had only five species of resident seabirds: wedge-tailed shearwaters (*Puffinus pacificus cuneatus*); white-tailed tropicbirds (*Phaethon lepturus dorotheae*); common noddies (*Anous stolidus pileatus*) and fairy (white) terns (*Gygis alba candida*), (Baker, 1951). The red-footed booby (*Sula sula rubripes*) and the greater frigatebird (*Fregata minor minor*) nest on nearby Rota island and may have been established on Guam prior to World War II. The only wedge-tailed shearwater colony, at Agana Heights, reported by Coultras (1931) apparently disappeared during the War and subsequent island development.

Major breeding colonies on Guam for boobies and noddy terns have been offshore islets at Orote, Pati and Facpi Points, as well as, Anae, Neye, and Alutom Islands (Figure 1).

The sole white-tailed tropicbird colony exists at Two Lover's Point although these birds have been infrequently observed resting at Orote Point, and were apparently known to nest along most northern cliffs before the war (Baker, 1951). Fairy terns utilize forested areas along the northern clifflines, particularly at Ritidian and Pati Point. Small colonies in isolated banyon trees at Andersen Air Force Base and Andersen South have recently been located. Cocos Island has apparently been the only breeding colony for fairy terns in the south.

In the past, information concerning seabirds on Guam has come from collected specimens, anecdotal observations by visiting researchers, sight records and photographs. Little quantitative work has been conducted other than counting adult and juvenile noddies flying adjacent to colonies (DAWR, 1979).

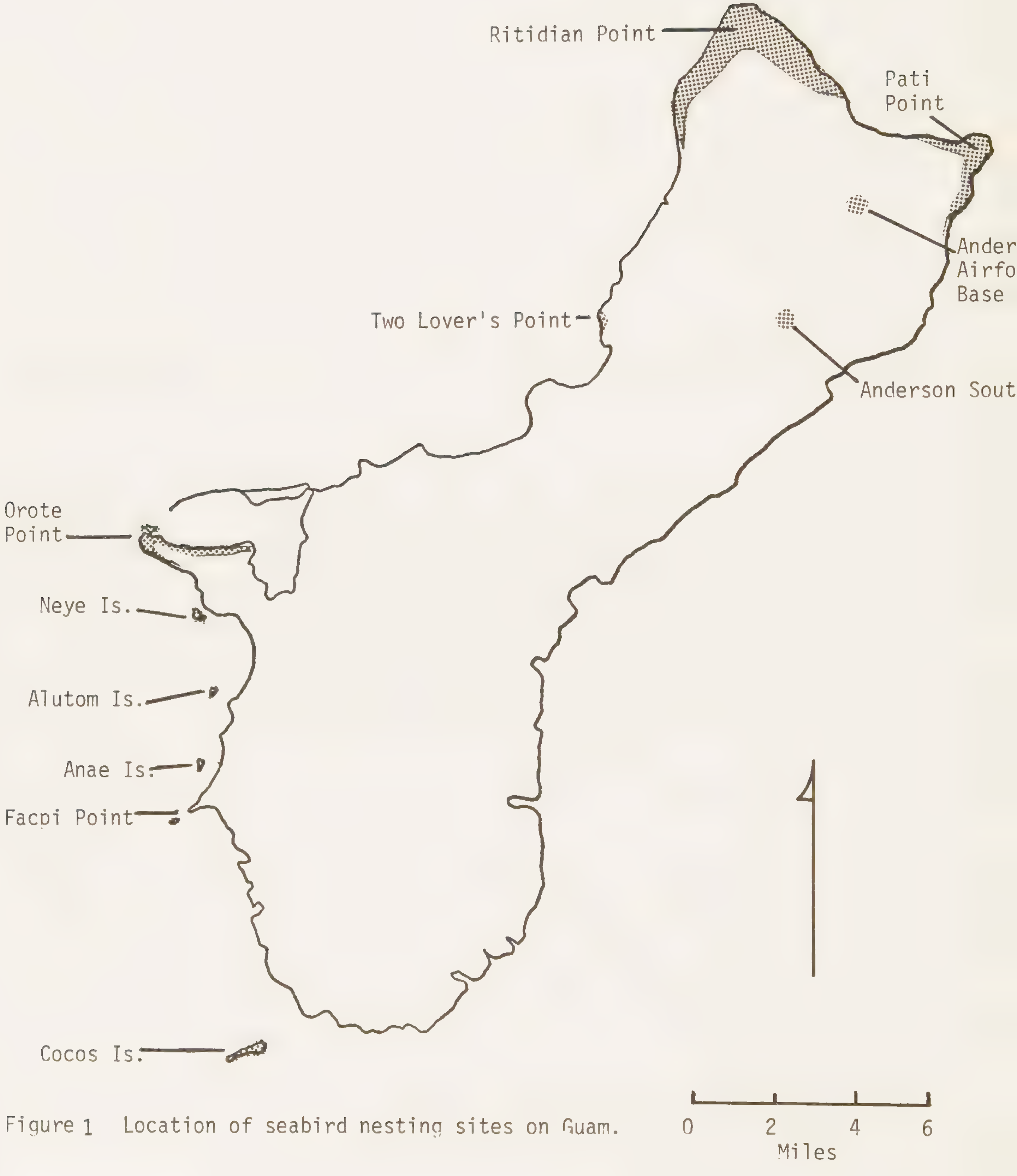
Ritidian Point
Pati Point
Ander Airfo Base
Two Lover's Point
Anderson Sout
Orote Point
Neye Is.
Alutom Is.
Anae Is.
Facpi Point
Cocos Is.
0 2 4 6
Miles

Figure 1 Location of seabird nesting sites on Guam.

Banding and collecting has recently been performed throughout the Northern Marianas in 1979 by the National Fish & Wildlife Laboratory, Smithsonian. One banded masked booby (Sula dactylatra and two banded sooty terns (Sterna fuscata) have been recovered on Guam since 1961.

Seabirds are important indicators of fishing grounds to local residents (Ashmole and Ashmole, 1967). While most subsistance fishing on Guam occurs in nearshore waters (0 to 10 miles offshore), commercial vessels will often fish in offshore waters at banks such as Eleven-mile Reef and Galvez and Rota Banks. Almost no research has been done on species composition and abundance in Guam's offshore waters, due to a lack accessible boats and personnel. Research has alos been needed to indicate any seasonal fluctuations in seabird populations that may coincide with fish migrations. Due to recently available vessels, initial research on seabirds in pelagic waters has been instigated.

OBJECTIVES

1. To determine breeding sites and approximate densities of seabird colonies on Guam.
2. To survey and inventory seabird abundance and species composition at banks, offshore and inshore waters.
3. To compile field notes on seabird feeding ecology and bird: fish associations whenever seabirds are encountered.

PROCEDURES

1. Known recorded breeding sites of noddy terns and brown boobies were visited periodically for evidence of nesting and to approximate population numbers. Prime habitat for fairy terns was surveyed for approximate densities, and data from roadside counts were used as an index to detect any significant changes in the numbers of fairy terns observed. The one colony of tropicbirds was censused frequently to determine the maximum number of pairs on island.
2. Seabird species and numbers were recorded during 40 counts in waters 1 to 450 miles from Guam. Pertinent data including location, feeding activities and age structure were recorded. Data were recorded by several trained observers from this Division on both day-fishing boats and during lengthy trips on the charter vessel Typhoon, a Pacific Tuna Development Foundation Seamount Groundfish Project. In the case of extended fishing trips, each day's observations were entered as one count.
3. Detailed field notes were compiled on the ecology and behavior of seabirds whenever encountered.

RESULTS

Brown boobies were recorded three times at Orote Point during 1980, but no evidence of nesting was determined. One brown booby was sighted at Pati Point and in addition, reliable reports from John Eads, President of the

Guam Fisherman's Coop, and a skilled observer of seabirds, indicate of the existance of a small colony at Pati Point, unobservable by land-based researchers.

A total of 16 adult and one juvenile white-tailed tropicbirds were observed during the highest count at Two Lover's Point. Birds were observed during June entering cuts in the cliff-face approximately 200 ft. down the 400 ft. cliff. Reports from marines from the Jungle Warfare School, who regularly practice rappeling at the Point, indicate nesting from at least May through August. As some birds were presumably out fishing on several surveys, the colony may hold as many as ten pairs.

Noddy tern colonies were observed periodically from March to October. Eighty nests containing eggs were counted on April 4 at Anae Island. A trip to the colony one week later revealed no eggs at any of the nests. Presumably, eggs had been collected by local residents (Schwindeman, pers. comm.). A boat survey in June recorded over one hundred adults and juveniles, with the adults exhibiting extremely aggressive behavior towards observers. Many adults had apparently renested successfully. Twenty-one pairs of noddies and 14 pairs of fairy terns were found nesting up to 40 ft. high in banyan trees on Andersen Air Force Base. Orote Point presumably still holds the greatest amount of nesting noddies, however, observers at stationary vantage points could not census all birds. Facpi Point, and Neye and Alutom Island varied from 20 to 40 presumably breeding individual noddies.

Fairy terns nest abundantly throughout the northern, cliffline limestone forests, particularly favoring ironwood and banyan trees. Counts in small areas at Ritidian Point indicate a density of up to three pairs per acre. A survey in July, 1980 at Cocos Island showed much nesting activity and Cocos appeared to have a higher density than Ritidian. Fairy terns have been observed to nest as closely as one meter apart on Midway Island (Howell, 1970). Fairy terns appear to be highly adaptable on Guam, nesting on trees at much-trafficed locations on Andersen Air Force Base, Andersen South, and the Navy Golf Course. Data from Table 9, Job W-4-1-3 show a significant decrease in fairy terns observed during North Central roadside counts ($P<.05$), as determined by the Mann-Whitney U-test (Sokal and Rohlf, 1969). Conversely, data show a significant increase in fairy terns observed during the North roadside counts ($P<.05$). These data fluctuations may reflect fairy terns' high mobility or indicate true population shifts. Combined data from all three roadside counts show no significant difference ($P<.05$) in the mean number of fairy terns observed per 100 miles of travel between FY 1979 and FY 1980.

Data from 40 pelagic seabird counts conducted from February through November, 1980 are presented in Table 1. Mean birds per count, relative abundance expressed as a percentage of a species' numbers relative to the total birds observed and frequency of occurrance (the number of counts containing a particular species) are recorded. Sixteen species of seabirds were observed in 1980, including three species unrecorded for Guam. New species include two Leach's storm petrels (Oceanodrama leucorhoa) observed at Rota Banks on March 25, 1980 and subsequently sighted several times afterwards by John Eads. Three little terns (Sterna albifrons) were recorded and photographed during shorebird transects (see Job 1, Table 1).

Table 1 Results of 40 pelagic seabird counts conducted from February through November 1980. Mean birds per count were obtained from 38 counts due to missing data. Counts = one day's observations of seabirds. Relative abundance = percentage of a species numbers relative to the total observed. Frequency of occurrence = number of counts containing a particular species, expressed as a percentage of total counts.

Species	Number	$\overline{x}$ Per Count	Relative Abundance	Frequency of Occurrence
Wedge-tailed Shearwater	17	0.45	0.41	7.50
Short-tailed Shearwater	14	0.37	0.34	10.00
Manx Shearwater	4	0.12	0.10	7.50
Pink-footed Shearwater	1	0.03	0.02	2.50
Unidentified Shearwater	129	3.39	3.12	2.25
Matsudaira Storm Petrel	14	0.37	0.34	20.00
Leach's Storm Petrel	2	0.05	0.05	2.50
Unidentified Storm Petrel	2	0.05	0.05	2.50
White-tailed Tropicbird	20	0.53	0.48	20.00
Red-footed Booby	506	13.32	12.18	27.50
Brown Booby	1180	31.05	28.84	50.00
Masked Booby	69	1.82	1.67	12.50
Greater Frigatebird	21	0.55	0.51	10.00
Common Tern	10	0.26	0.24	20.00
Black-naped Tern	3	0.08	0.07	2.50
Sooty Tern	5	0.13	0.12	7.50
Noddy Tern	2027	53.34	48.81	47.50
Fairy Tern	96	2.23	2.31	27.50
Unidentified Flock	33	0.87	0.79	10.50
TOTAL	4153	N=38	100.00	N=40

A single pink-footed shearwater (Puffinus creatopus) was observed closely by Michael Molina, a biologist aboard the charter vessel Typhoon on April 4, 1980. This is a new record for Micronesia. This species has been recently recorded extending its range in the Pacific (Collins, pers. comm.). Masked boobies, seen for the first time on Guam in 1979, were observed foraging in offshore waters on 31% of all counts, indicating an abundance previously unrecorded.

Data show noddy terns as the most abundant species on all counts, being present on 47% of the counts. Brown boobies, while only accounting for 28% of individuals recorded were observed on 50% on all counts. The family Sulidae, as a whole, accounted for 42.69% of birds recorded, while all terns comprised 51.55% of the total. Shearwaters only totaled 4% of all individuals and yet at least one shearwater could be seen on 42.5% of all counts. Frigatebirds, tropicbirds and storm petrels each accounted for approximately .5% of the total.

Tables 2-4 present the recorded data from the 40 counts by feeding areas. Data are presented for each seabird family or subfamily, with terns being broken down into species due to the highly variable feeding habits within the subfamily.

Shearwaters were most abundant in near-shore waters and yet showed the highest frequency of occurrence at offshore banks. Surprisingly, since shearwaters as a group are considered highly pelagic wanderers (Harrison, 1978), on offshore counts they showed the lowest mean per count and only accounted for 2% of the total individuals recorded.

Storm petrels were found in very small numbers in all three areas. Attesting to this family's pelagic habits, storm petrels showed a 44% frequency of occurrence on banks, as opposed to only an 8% frequency of occurrence in near-shore waters.

Tropicbirds were found on near-shore and off-shore counts only. The greatest bulk of birds were recorded on near-shore waters which may be due to observations along the shore near their nesting areas, or a reflection of this birds' foraging preferences (Ashmole and Ashmole, 1967).

Boobies occured most frequently near-shore and least frequently at fishing banks. They accounted for almost half the birds observed at banks and near-shore, with a lower percentage of the total on off-shore counts. Data indicate a high percentage of adults (60%-90%) on off-shore and bank surveys, with juveniles making up almost 50% of inshore counts.

Frigatebirds showed the highest population of individuals and the greatest frequency of occurrence in near-shore waters, owing to their habit of robbing incoming seabirds of their day's catch. Frigatebird colonies on islands in the Northern Marianas accounted for several near-shore observations as well.

Terns, as a group, had the highest number of individuals and the greatest relative abundance of any group in near-shore and offshore waters, and only slightly below the numbers of boobies found at banks. Their frequency of occurrence was the greatest of all groups in every area, with at least one species of tern found in every count near-shore. Noddies accounted for the

Table 2. Results of 12 pelagic seabird counts conducted on NEAR SHORE waters, less than 10 miles from an island. Counts = one day's observations of seabirds. Relative abundance = percentage of that Families' numbers relative to the total observed. Frequency of occurrence = number of counts containing members of the Family expressed as a percentage of the total number of counts. Terns were broken down into species due to high variation in feeding preferences.

Families & Subfamilies	Number	$\bar{x}$ Per Count	Relative Abundance	Frequency Occurrence
Shearwaters	105	8.75	4.75	33.33
Storm Petrels	2	0.17	0.09	8.33
Tropicbirds	17	1.42	0.77	41.67
Boobies	1016	84.67	45.95	83.33
Frigatebirds	17	1.42	0.77	16.67
Terns	1054	87.83	47.67	100.00
Common	7	0.58	0.32	41.67
Black-naped	3	0.25	0.14	8.33
Sooty	4	0.33	0.18	16.67
Noddy	999	83.25	45.18	66.67
Fairy	41	3.42	1.85	50.00
TOTAL	2211	N = 12	100.00	

Table 3. Results of 17 pelagic seabird counts conducted on OFFSHORE waters, greater than 10 miles from an island. Counts = one day's observations of seabirds. Relative abundance = percentage of the families' numbers relative to the total observed. Frequency of occurrence = number of counts containing members of the family expressed as a percentage of the total number of counts. Terns were broken down into species due to high variation in feeding preferences.

Families & Subfamilies	Number	$\bar{x}$ Per Counts	Abundance	Frequency of Occurrence
Shearwaters	25	1.47	2.10	41.18
Storm Petrels	7	0.41	0.59	23.53
Tropicbirds	3	0.18	0.25	17.65
Boobies	398	23.41	33.42	58.82
Frigatebirds	3	0.18	0.25	5.88
Terns	755	44.41	63.39	88.23
Common	1	0.06	0.08	5.88
Black-naped	0	0	0	0
Sooty	1	0.06	0.08	5.88
Noddy	728	42.82	61.13	52.94
Fairy	25	1.47	2.10	23.53
TOTAL	1191	N = 17	100.00	

Table 4. Results of nine pelagic seabird counts conducted on offshore BANKS. Counts = one day's observations of seabirds. Relative abundance = percentage of that families' numbers relative to the total observed. Frequency of occurrence = number of counts containing members of the family, expressed as a percentage of the total number of counts. Terns were broken down into species due to high variation in feeding preferences.

Families & Subfamilies	Number	$\bar{x}$ Per Count	Relative Abundance	Frequency of Occurrence
Shearwaters	35	3.89	4.87	55.56
Storm Petrels	9	1.00	1.25	44.44
Tropicbirds	0	0.0	0	0
Boobies	341	37.89	47.49	33.33
Frigatebirds	1	0.11	0.14	11.11
Terns	332	36.89	46.24	55.55
Common	2	0.22	0.28	22.22
Black-naped	0	0	0	0
Sooty	0	0	0	0
Noddy	300	33.33	41.78	22.22
Fairy	30	3.33	4.18	11.11
TOTAL	78	N = 9	100.00	

majority of all tern observations, but were found in significantly lower numbers ($P<.05$) at offshore banks.

Sooty and black-naped terns were not recorded on banks and were most abundant in near-shore waters. While the black-naped tern is known to be an inshore forager, sooties regularly forage as far as 700 miles from nest sites during the breeding season. (Diamond, 1971; Brown, 1976). It is surprising greater numbers were not found in off-shore waters.

Common terns, also inshore feeders, were recorded on 42% of near-shore counts. Six additional observations made during routine field work recorded common terns foraging in bays close to shore. While not resident on Guam, these terns can apparently be found in small numbers thoughout the year.

Fairy terns, although comprising a large proportion of resident seabirds on Guam, were found in considerably smaller numbers than noddy terns in all foraging areas. They were relatively most abundant at fishing banks although they were found to occur on one half of all near-shore counts. Fairy terns are known to forage widely for food, especially following migrant schools of mahi-mahi, and any individual count could easily miss large flocks occuring at distant areas. (Ashmole and Ashmole, 1967).

Field notes documenting feeding methods on all species were collected. However, more research is needed before any definite statement can be made concerning the ecology or life histories of seabirds on Guam. The ability to document population trends of resident seabirds would be of value to Guam's fishermen, particularly in the face of increasing environmental contamination.

RECOMMENDATIONS

1. To continue to survey seabird colonies on Guam, by both sea and land, to determine densities and approximate population levels of resident species.

2. To continue to survey pelagic seabirds on near-shore and off-shore waters and at fishing banks. Surveys should be made during each of the major fishing runs, to document any significant changes in species composition or abundance.

3. To continue to collect field observations on life histories, growth rates, and feeding habits of seabirds on Guam.

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Report Prepared by: Anne F. Maben

Fairy terns

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Survey and Inventory of Native Land Birds on Guam and Northern Mariana Islands.

PERIOD COVERED: October 1, 1979 through September 30, 1980

SUMMARY

Of the ten native birds of Guam proposed for inclusion on the U.S. Endangered Species List, seven species have recorded declines in population and one species has shown a slight population increase in roadside counts conducted during fiscal year 1980 in 3 areas of northern Guam.

Population densities and indices of relative abundance, species incidence and species frequency were estimated from 15 min. station counts in northern Guam. Similar counts done on Saipan and Rota are being analyzed to provide a basis for comparison in population levels on Guam.

A paper entitled, "Life Histories of the Native Forest Birds of Guam" has been completed for publication and yields important information vital to future research projects.

BACKGROUND

Because of significant population declines in the last 10 years, ten species of native forest birds have been proposed as candidates for the federal Endangered Species List. Factors such as destruction of habitat, pesticide use, predation, and possible avian disease may be impacting the bird populations, and these birds are now restricted primarily to the northern cliffline limestone forests.

Roadside counts have been conducted since the early 1960's over 3 routes in northern Guam and can be used as general indicators of long range population increase or decrease. In addition, it was felt that more accurate estimations of population numbers, density and indices were needed in the few areas where the forest birds remain. Similar censuses on islands of the Northern Marianas, where bird populations appear quite abundant, would provide a basis for comparison.

In order to determine the causes of decline in these native species as well as design any future recovery plans, basic research needed to be done on native birds. Life histories, ecology and behavior needed to be incorporated into censusing programs to accurately analyse trends.

OBJECTIVES

1. To determine and monitor the status of the native forest birds on Guam.

2. To census natural habitats for population estimates and densities of rare birds on Guam and the Northern Mariana Islands.

3. Complete a manuscript dealing with the life histories, ecology, and behavior of Guam's native forest birds.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). These routes were driven at approximately 10-15 miles per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of distance from the observer.

2. Fifteen-minute station counts were made at nine locations in the northern cliffline area and two locations in the northern plateau forests on Guam (Figure 2). These stations were censused monthly from sunrise to within four hours after sunrise. Birds seen or heard were recorded along with the distance at which the birds were observed. Estimated detection area for each species was computed to later approximate bird densities (Table 1). Following Shallenberger (1978), these data were used to generate three indices of species abundance for each census station.

   Species Frequency - Number of count periods during which a species was recorded, divided by the total number of count periods.

   Species Incidence - Number of birds of a species recorded, divided by the number of count periods during which the species was recorded.

   Relative Abundance - The number of birds of a species recorded, divided by the number of the most abundant species recorded during the same count periods.

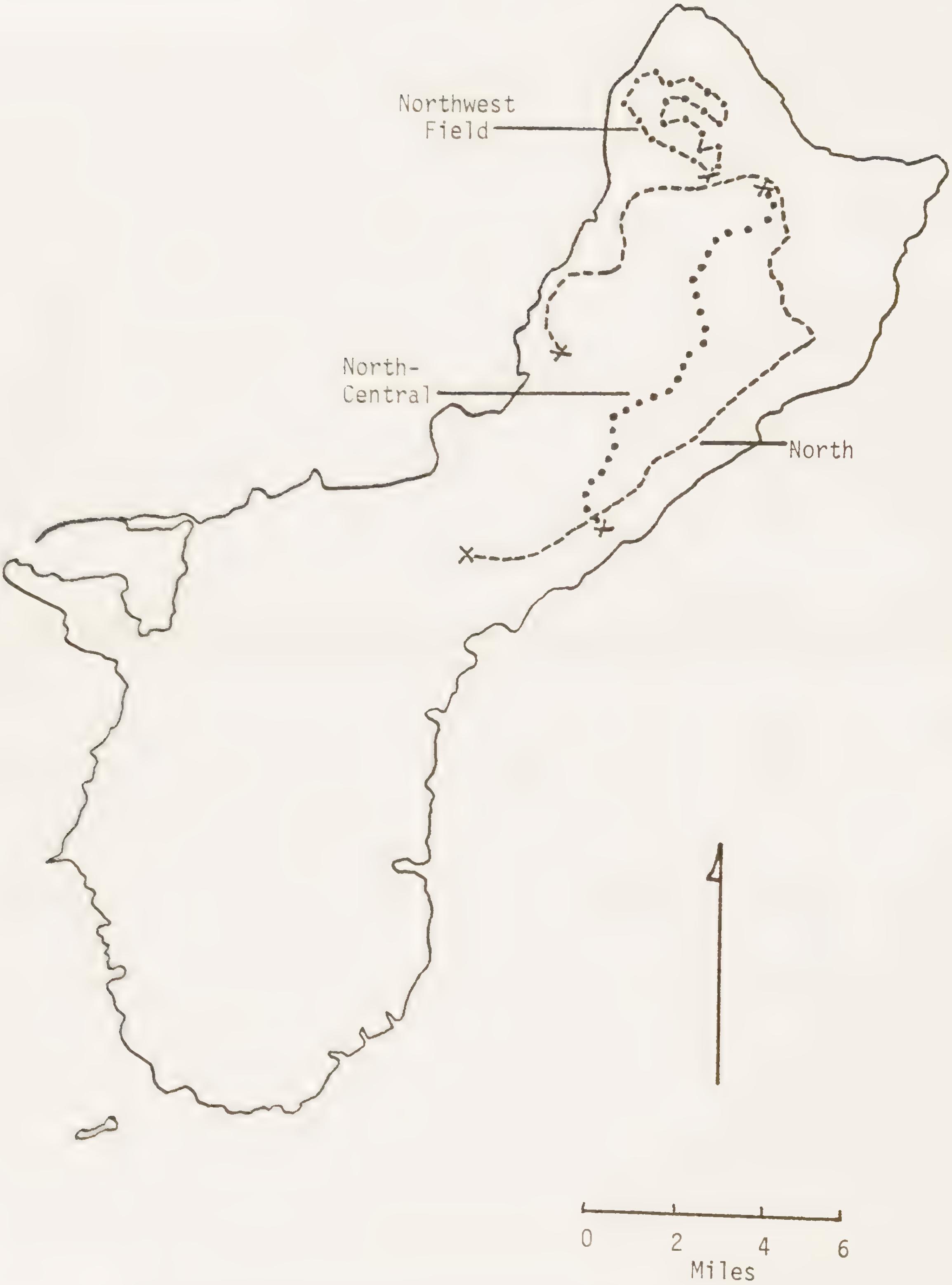
Population densities for each species at the 11 stations were determined by using the variable circular plot method described by Reynolds et. al. (1980). Estimates of population densities from all 11 stations were combined to determine average population densities for each species during four quarterly periods.

Similar station counts were conducted on Saipan in January, 1980 and on Rota in July 1980.

RESULTS

Roadside Counts

Data from the roadside counts conducted during Fiscal Year 1979 and Fiscal 1980 are presented in Tables 2-7, expressed as the number of birds of each


Northwest
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North-
Central
North
0
2
4
6
Miles

Figure 1. North, North-Central, and Northwest Field Roadside Bird Census Routes.

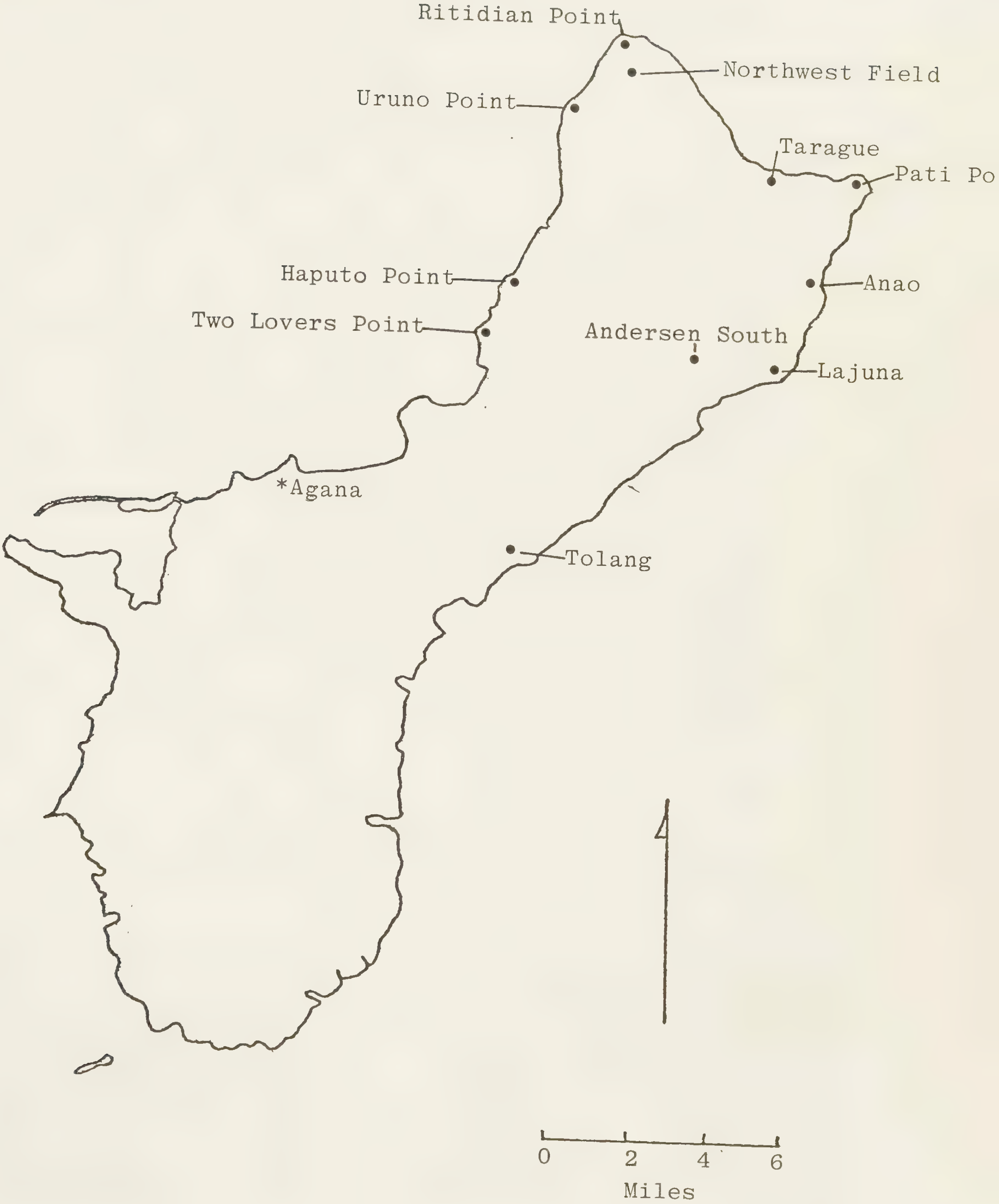
Ritidian Point
Northwest Field
Uruno Point
Taragué
Pati Po
Haputo Point
Anao
Two Lovers Point
Andersen South
Lajuna
*Agana
Tolang
0
2
4
6
Miles

Figure 2. Eleven cliffline and 2 plateau stations in Northern Guam.

Table 1. Estimated detection area per point count of each species, using the method described by Reynolds et.al. (1980).

Species	Detection Area (Hectares Per Point)
Bittern	2.63*
Broadbill	.58
Crow	1.77
Fantail	.20
Fruit Dove	2.09
Ground Dove	.20
Honeyeater	.20
Kingfisher	1.09
Rail	.14
Starling	.38
White-eye	.16
Swiftlet	unknown

*Because of insufficient data, detection area was determined by using the farthest distance the species could be heard.

Micronesian kingfisher

Rufous-fronted fantail

Table 2. Number of birds per 100 miles of travel observed each month on the Northwest Field roadside count route during Fiscal Year 1979.

	1978			1979										
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	$\bar{X}$/COUNT	$\bar{X}$/ 100 mi
Bittern	8.3	4.2	8.3	4.1	29.0	8.5	11.2	16.3	17.1	4.2	17.4	17.1	36	1.4	12.1
Black Crow	16.6	20.9	25.5	8.3	20.7	17.1	5.6	20.3	29.8	50.2	100.0	72.6	92	3.7	47.3
Drongo	377.6	71.1	89.4	95.0	290.5	235.0	486.0	837.4	229.8	330.5	217.4	299.1	910	36.4	296.6
Fantail	24.9	33.5	17.0	4.1	8.3	8.5	11.2	36.6	8.5	12.6	26.1	4.3	48	1.9	16.3
Fruit Dove	0	0	0	0	0	0	0	0	0	12.6	0	8.5	5	0.2	1.8
Golden Plover	132.8	125.5	59.6	78.5	70.5	38.5	14.0	0	0	0	169.6	17.1	169	6.8	64.2
Ground Dove	0	0	0	0	0	8.5	2.8	12.2	8.5	0	4.4	4.3	10	0.4	3.7
Honeyeater	41.5	29.3	12.8	4.1	16.6	8.5	11.2	40.7	8.5	12.6	13.0	17.1	53	2.1	18.0
Kingfisher	20.7	12.6	8.5	4.1	4.1	4.3	11.2	12.2	4.3	16.7	13.0	8.5	30	1.2	10.0
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	99.6	150.6	51.1	124.0	128.6	119.7	112.0	235.8	302.1	255.2	252.2	239.3	505	20.2	172.5
Quail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	8.3	0	21.3	4.1	8.3	12.8	2.8	24.4	0	4.2	8.7	12.8	26	1.0	9.0
Rice Bird	0	83.7	34.0	41.0	24.9	17.1	5.6	8.1	0	0	0	25.6	58	2.3	21.8
Sparrow	0	0	0	0	0	0	0	0	12.8	0	0	12.8	6	0.2	2.3
Starling	170.1	108.8	59.6	86.8	166.0	145.3	108.9	174.8	93.6	125.5	230.4	213.7	413	16.5	140.3
White Tern	0	0	29.8	4.1	4.1	4.3	0	4.1	0	8.4	0	0	13	0.5	4.6
Miles	24.1	23.9	23.5	24.2	24.1	23.4	35.8	24.6	23.5	23.9	23.0	23.4	297.4	11.9	
Counts	2	2	2	2	2	2	3	2	2	2	2	2	25		

Table 3. Number of birds per 100 miles of travel observed each month on the Northwest Field roadside count route during Fiscal Year 1980

	1979			1980											
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	#/COUNT	# 100 mi
Bittern	12.0	12.8	57.4	8.6	0	16.4	11.2	8.30	8.03	0	11.8	4.4	39	1.70	13.6
Black Crow	39.8	42.6	36.9	0	0	24.6	19.6	24.9	28.1	54.1	118.0	30.7	109	4.70	34.9
[illegible]	266.9	85.1	331.9	321.6	247.9	491.7	190.5	256.8	676.7	324.3	675.5	137.4	1,260	54.78	439.5
[illegible]	19.9	7.0	12.3	21.6	16.5	65.6	11.2	29.0	0	18.0	26.5	0	57	2.48	19.8
Fruit Dove	4.0	12.8	0	0	8.3	16.4	16.8	4.1	0	0	2.9	21.9	22	0.96	7.3
Golden Plover	43.8	106.4	73.8	77.6	33.1	8.2	8.4	0	0	0	14.7	21.9	91	3.96	32.3
Ground Dove	27.9	4.3	4.1	4.3	0	4.1	8.4	12.4	4.0	27.0	5.9	0	23	1.00	8.1
Honeyeater	15.9	8.5	32.8	30.2	16.5	12.3	14.0	24.9	4.0	0	28.3	13.2	55	2.39	19.3
Kingfisher	27.9	29.8	65.6	25.9	8.3	4.1	19.6	4.1	4.0	36.0	14.7	8.8	58	2.52	20.3
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	215.1	97.9	168.0	245.7	82.6	295.1	252.1	282.2	224.9	333.3	362.8	122.8	659	28.62	231.1
Quail	0	0	4.1	0	0	0	0	0	0	0	0	0	1	0.04	0.3
Rail	12.0	25.5	16.4	12.9	0	20.5	0	4.1	16.1	0	8.8	0	29	1.26	9.7
Rice Bird	15.9	0	0	8.6	165.3	155.7	50.4	87.1	84.3	117.1	56.0	0	156	6.78	61.7
Sparrow	0	0	0	0	0	24.6	0	8.3	0	0	0	8.8	8	0.35	3.4
Starling	227.1	80.9	184.4	306.0	99.2	180.3	243.7	186.7	297.2	225.2	200.6	39.5	556	24.17	189.2
White Tern	0	0	0	4.3	0	12.3	42.0	4.1	32.1	9.0	2.9	17.5	34	1.48	10.4
Miles	25.1	23.5	24.4	23.2	12.1	24.4	35.7	24.1	24.9	11.1	33.9	22.8	285.2	12.4	
Counts	2	2	2	2	1	2	3	2	2	1	2	2	23		

Table 4. Number of birds per 100 miles of travel observed each month on the North-Central roadside count during Fiscal Year 1979.

	1978			1979										
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	$\bar{X}$/COUNT	$\bar{X}$/ 100 mi
Bittern	42.5	26.1	16.6	17.3	17.7	10.2	32.3	2.3	10.5	13.7	13.7	22.4	71	2.7	32.1
Black Crow	0	0	6.6	4.0	0	0	0	0	0	0	0	0	2	0.8	0.6
Drongo	87.2	127.5	115.9	103.8	297.9	88.1	114.7	91.3	157.3	130.6	119.5	139.0	505	19.4	131.1
Fantail	0	0	3.3	17.3	17.7	3.4	28.7	0	0	0	6.8	0	22	0.9	6.4
Fruit Dove	0	0	0	0	14.2	3.4	0	2.3	7.0	0	0	0	8	0.3	2.2
Golden Plover	400.4	585.0	334.4	799.3	1262.4	444.1	186.4	0	0	10.3	0	910.3	1,750	67.3	411.1
Ground Dove	29.1	9.8	0	0	31.9	13.6	7.2	13.7	17.5	6.9	13.7	0	48	1.9	12.0
Honeyeater	0	0	3.3	0	0	3.4	0	0	0	6.9	0	0	4	0.2	1.1
Kingfisher	6.7	9.8	23.2	6.9	10.6	0	7.2	0	7.0	3.4	10.2	0	26	0.9	7.1
Noddy Tern	0	0	3.3	0	0	0	0	0	0	0	0	0	1	0.5	0.3
P. T. Dove	111.9	98.0	102.6	114.2	163.1	67.8	93.2	89.0	143.4	116.8	85.3	148.0	408	15.7	111.1
Quail	100.7	0	0	0	24.8	0	32.3	105.0	139.9	0	54.6	0	163	6.3	38.1
Rail	58.2	32.7	59.6	17.3	24.8	33.9	32.3	13.7	35.0	24.1	37.5	17.9	123	4.7	32.3
Rice Bird	152.1	22.9	6.6	45.0	31.9	139.0	107.5	157.5	150.3	58.4	116.0	89.7	353	13.6	89.7
Sparrow	13.4	111.1	13.2	0	14.2	33.9	28.7	38.8	42.0	34.4	0	94.2	126	4.9	35.3
Starling	22.4	16.3	6.6	3.5	0	16.9	43.0	13.7	17.5	17.2	20.5	0	57	2.2	14.8
White Tern	161.1	45.8	19.9	0	3.5	23.7	3.6	11.4	38.5	6.9	0	0	119	4.6	26.2
Plumed Egret	0	186.3	0	72.7	0	30.5	60.9	4.6	0	0	0	0	106	4.1	29.6
Miles	44.7	30.6	30.2	28.9	28.2	29.5	27.9	43.8	28.6	29.1	29.3	22.3	373.1	14.35	
Counts	3	2	2	2	2	2	2	3	2	2	2	2	26		

Table 5. Numbers of birds per 100 miles of travel observed each month on the North-Central roadside count during Fiscal Year 1980.

	1979			1980										
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	$\overline{X}$/COUNT	$\bar{X}$/ 100 mi
Bittern	25.6	12.1	12.2	16.3	12.8	20.9	40.8	15.0		8.7	4.1	2.4	48	1.9	15.5
Black Crow	0	0	0	0	0	0	0	0		0	0	0	0	0	0
Drongo	226.5	173.4	126.5	113.8	64.1	125.5	71.4	157.3		65.5	111.1	93.5	355	14.2	120.8
Fantail	0	0	0	0	0	12.6	0	7.5		0	0	0	5	0.2	1.8
Fruit Dove	4.3	0	0	0	4.3	4.2	0	0		0	4.1	0	4	0.2	1.5
Golden Plover	1500.0	366.93	1146.9	1276.4	521.4	1539.8	418.4	3.7		0	0	95.9	1,732	69.3	624.5
Ground Dove	8.5	4.0	12.2	8.1	0	8.4	7.7	0		0	0	0	13	0.5	4.4
Honeyeater	0	0	0	0	0	0	0	0		0	0	0	0	0	0
Kingfisher	4.3	0	4.1	0	0	0	0	11.2		0	0	0	5	0.20	1.78
Noddy Tern	0	0	0	0	0	0	0	0		0	0	0	0	0	0
P. T. Dove	128.2	88.7	44.9	56.9	89.7	58.6	66.3	74.9		109.2	28.8	19.2	204	8.2	69.6
Quail	0	0	0	4.1	0	0	0	0		0	0	0	1	0.04	0.4
Rail	0	36.3	36.7	20.3	0	0	23.0	22.5		0	0	14.4	44	1.8	13.9
Rice Bird	239.3	4.0	236.7	0	0	83.7	96.9	82.4		0	0	0	195	7.8	67.5
Sparrow	94.0	112.9	12.2	0	183.8	96.2	51.0	131.1		30.6	0	95.9	221	8.8	73.4
Starling	8.5	4.0	4.1	0	0	8.4	12.8	3.7		0	8.2	4.8	16	0.6	5.0
White Tern	0	24.2	28.6	8.1	4.3	16.7	23.0	71.2		0	0	0	48	1.9	16.0
Plumed Egret	111.1	0	0	28.5	0	0	0	0		0	0	0	33	1.3	12.7
Miles	23.4	24.8	24.5	24.6	23.4	23.9	39.2	26.7		22.9	24.3	36.0	293.7	12.2	
Counts	2	2	2	2	2	2	3	2		2	2	3	24		

Table 6. Number of birds per 100 miles observed each month on the North roadside count during Fiscal Year 1979.

	1978			1979										
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	$\bar{X}$/COUNT	$\bar{X}$/ 100 mi
Bittern	17.4	8.1	14.4	10.6	8.5	0	2.1	6.8	15.6	1.3	1.9	27.8	63	2.25	9.5
Black Crow	0	2.0	0	0	0	0	0	0	0	15.3	0	2.0	14	0.5	1.6
Drongo	144.8	82.8	47.4	35.9	46.5	66.8	56.8	55.8	66.3	129.2	35.1	63.6	505	18.0	69.3
Fantail	0	2.0	0	6.3	8.5	6.1	0	2.7	2.0	3.8	0	0	17	0.6	2.6
Fruit Dove	0	0	0	0	0	0	0	1.4	0	3.8	0	0	4	0.1	0.4
Golden Plover	139.4	66.7	51.5	63.4	46.5	52.6	92.6	6.8	0	0	0	19.9	299	10.7	45.0
Ground Dove	8.0	2.0	2.1	4.2	6.3	2.0	6.3	2.7	3.9	3.8	3.9	2.0	27	1.0	3.9
Honeyeater	0	0	4.1	0	0	0	2.1	1.4	5.8	3.8	0	0	10	0.4	1.4
Kingfisher	12.1	0	0	2.1	0	2.0	2.1	4.1	0	5.1	0	2.0	20	0.7	2.5
Noddy Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P. T. Dove	42.9	28.3	45.4	14.8	27.5	14.2	25.3	17.7	15.6	94.6	19.5	43.7	234	8.4	32.4
Quail	0	0	0	0	0	0	0	28.6	0	2.6	1.9	0	24	0.9	2.8
Rail	4.0	2.0	10.3	2.1	19.0	8.1	4.2	8.2	7.8	3.8	11.7	2.0	45	1.6	6.9
Rice Bird	8.0	20.2	0	21.1	0	87.0	21.1	17.7	27.3	11.5	0	0	115	4.1	17.8
Sparrow	55.0	16.2	82.5	0	6.3	0	31.6	5.4	23.4	20.5	46.8	6.0	166	5.9	24.5
Starling	12.1	10.1	4.1	8.5	8.5	6.1	2.1	12.2	15.6	39.6	9.7	11.9	88	3.1	11.7
White Tern	4.0	2.0	8.2	0	19.0	4.0	12.6	4.1	4.0	2.6	7.8	0	36	1.3	5.7
Miles	74.6	49.5	48.5	47.3	47.3	49.4	47.5	73.5	51.3	78.2	51.3	50.3	668.7	23.9	
Counts	3	2	2	2	2	2	2	3	2	4	2	2	28		

Table 7. Number of birds per 100 miles observed each month on the North roadside count during Fiscal Year 1980.

	1979			1980										
SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	$\bar{X}$/COUNT	X/ 100 mi
Bittern	8.3	18.6	21.1	10.4	10.4	2.1	4.2	0	17.1		2.7	4.2	46	2.3	9.0
Black Coot	2.1	0	2.1	8.3	0	0	0	0	0		0	0	6	0.3	1.1
Drongo	43.5	47.6	61.2	43.6	56.3	66.3	45.8	85.1	43.2		93.4	33.4	250	12.5	50.9
Fantail	0	0	0	0	0	0	0	0	2.1		0	0	1	0.1	0.2
Fruit Dove	0	0	0	0	0	0	8.3	0	0		2.7	2.1	4	0.2	1.2
Golden Plover	74.5	26.9	156.1	215.8	83.3	66.7	0	0	0		0	20.9	309	15.5	58.5
Ground Dove	4.1	2.1	0	2.1	4.2	6.2	12.5	17.0	8.5		8.2	0	23	1.2	5.9
Honeyeater	0	0	0	0	14.6	0	0	0	0		0	0	7	0.4	1.3
Kingfisher	2.1	0	0	2.1	0	0	0	0	0		2.7	0	3	0.2	0.6
Noddy Tern	0	0	0	0	0	0	0	0	0		0	4.2	2	0.1	.4
P. I. Dove	26.9	24.8	27.4	64.3	14.6	37.3	8.3	17.0	19.2		19.2	31.3	131	6.6	26.4
Quail	0	2.1	0	0	0	0	0	0	0		0	0	1	0.1	0.2
Rail	4.1	4.1	4.2	0	0	2.1	0	0	4.3		0	6.3	12	0.6	2.3
Rice Bird	0	80.7	0	0	20.8	82.8	0	0	0		186.8	0	157	7.9	33.7
Sparrow	0	8.3	40.1	78.8	41.7	33.1	8.3	12.8	21.4		0	6.3	115	5.8	22.8
Starling	0	0	8.4	16.6	4.2	4.1	0	0	12.8		24.7	4.2	33	1.7	6.8
White Tern	2.1	4.1	10.5	51.9	4.2	20.7	0	8.5	0		0	2.1	48	2.4	9.5
Miles	48.8	48.3	47.4	48.2	48.0	48.3	24.0	23.5	46.8		36.4	47.9	467.6	23.4	
Counts	2	2	2	2	2	2	1	1	2		2	2	20		

species observed per 100 miles of travel each month. In order to illustrate population changes during the last year, Tables 8 through 10 present the mean number of birds seen per 100 miles as well as the standard deviation and coefficient of variation. Changes between years were tested for significance using the Mann-Whitney U-Test (Sokal and Rohlf, 1969). Those years with significant ($P<.05$) differences are indicated with an asterisk. Examination of these tables in general show a trend towards population decline in the North-Central and North roadside counts, although native doves showed a slight increase in numbers along the Northern route. Increased development throughout the northern plateau could definitely have had an impact on populations along these routes. The Northwest Field roadside counts showed slight increases in 5 species of forest bird populations. This increase may reflect a more successful breeding season or recruitment from the northern plateau. Counts conducted on the three established roadside routes necessarily sample bird populations in more disturbed habitat than station counts in relatively pristine areas. Comparison between numbers generated by the two sampling methods may not be an accurate reflection of true population trends.

Station Counts

Density values determined for each species at 11 stations over the past two fiscal years (1979 and 1980) are presented in Tables 11 and 12. In addition, average densities were determined for each quarterly period during both fiscal years (Table 13). Indices of relative abundance, species incidence, and species frequency for Fiscal Years 1979 and 1980 are found in Tables 14 through 19. Because apparent population trends are different for each species, they will be discussed separately, using data gathered during both roadside and stations counts. Table 20 compares 8 and 15-minute sampling periods.

Chinese Least Bittern - *Ixobrychus sinensis*

No signigicant changes in bittern population were indicated by either roadside or station counts during FY 1979 or FY 1980. No seasonal trends were evident either, lending support to Jenkins (1981) assertion that the bittern is a year-round breeder. This species is the only native bird still commonly observed in southern Guam and appears to be holding its own in the face of overall declines in other bird populations.

Guam Rail - *Rallus owstoni*

Roadside counts indicated a significant ($P<.05$) decline in rail population in the North and North-Central routes, reflecting a steady decrease in population over the past six years. Since roadside counts have been shown to be a relatively insenstive method of censusing true population numbers (DAWR 1979), play-back of tape recorded calls were used experimentally on selected counts to better reveal rail abundance. This technique indicated higher rail numbers than recorded on regular roadside routes, yet 10 station counts nevertheless recorded population decreases.

Jenkins (1979) has suggested the heavy use of pesticides by the military, habitat destruction and introduced predators as possible factors in rail population decline. The highest density of this species appears to be on Andersen South and this area may be now be last stronghold of the Guam rail.

Table 8. Results of the Northwest Field roadside counts conducted during FY 1979 and FY 1980, showing the mean number of birds seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

	FY 1979			FY 1980		
Species	$\overline{X}$	σ	CV	$\overline{X}$	σ	CV
Bittern	12.1	7.5	62.0	12.6	15.0	118.8
Black Crow	47.3	55.9	118.2	34.9*	30.6	87.7
Drongo	296.6	210.0	70.8	439.5	334.8	76.2
Fantail	16.3	11.3	69.3	19.8	17.0	85.7
Fruit Dove	1.8	4.2	238.8	7.3*	7.8	107.5
Golden Plover	64.2	57.9	90.2	32.3*	35.8	110.7
Ground Dove	3.7	4.3	116.2	8.5*	9.4	110.5
Honeyeater	18.0	12.4	68.9	16.7	10.4	62.3
Kingfisher	10.0	5.4	54.0	20.8*	18.1	87.1
Noddy Tern	0	0	0	0	0	0
P.T. Dove	172.5	79.6	46.1	233.5*	90.5	40.5
Quail	0	0	0	0.3	1.2	3.5
Rail	9.0	7.8	86.7	9.7	8.9	91.8
Rice Bird	21.8	25.0	114.8	61.7*	60.5	98.1
Sparrow	2.3	5.2	222.5	3.4	7.4	213.7
Starling	140.3	52.2	37.2	189.2*	81.7	43.2
White Tern	4.6	8.4	184.1	10.4	13.8	1.3

Table 9. Results of the North Central roadside counts conducted during FY 1979 and FY 1980, showing the mean number of birds seen per 100 miles of travel, the standard deviation on (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

	FY 1979			FY 1980		
Species	$\overline{X}$	σ	CV	$\overline{X}$	σ	CV
Bittern	32.1	47.0	146.3	15.5	10.7	69.0
Black Crow	0.6	1.9	346.4	0	0	0
Drongo	131.1	56.7	43.2	120.8	49.9	41.3
Fantail	6.4	9.6	148.8	1.8*	4.2	231,1
Fruit Dove	2.2	4.3	193.6	1.5	2.1	138.8
Golden Plover	411.1	413.4	100.6	624.5*	621.8	99.6
Ground Dove	12.0	10.5	87.9	4.4*	4.6	104.3
Honeyeater	1.1	2.2	196.7	0*	0	0
Kingfisher	7.1	6.4	90.6	1.78*	3.5	199.1
Noddy Tern	0.3	1.0	346.4	0	0	0
P.T. Dove	111.1	28.2	25.4	69.6*	33.0	47.5
Quail	38.1	50.4	132.2	0.4*	1.2	331.7
Rail	32.3	14.6	45.4	13.9*	14.8	106.2
Rice Bird	89.7	55.0	61.3	67.5*	92.9	137.5
Sparrow	35.3	34.7	98.2	73.4*	59.4	81.0
Starling	14.8	11.8	79.9	5.9*	4.2	84.0
White Tern	26.2	45.2	172.5	16.0*	21.3	133.2

Table 10. Results of the North roadside counts conducted during FY 1979 and FY 1980, showing the mean number of birds seen per 100 miles of travel, the standard deviation (σ) and the coefficient of variation (CV). Asterisks indicate means significantly different ($P<.05$) from the preceeding year as determined by the Mann-Whitney U-Test.

	FY 1979			FY 1980		
Species	$\bar{X}$	σ	CV	$\bar{X}$	σ	CV
Bittern	9.5	8.2	86.0	9.0	7.2	80.4
Black Crow	1.6	4.4	272.3	1.1	2.5	229.1
Drongo	69.3	34.6	50.0	50.9*	24.6	48.4
Fantail	2.6	3.0	113.3	0.2*	0.6	331.7
Fruit Dove	0.4	1.1	261.7	1.2*	2.5	214.1
Golden Plover	45.5	42.9	95.5	58.5	71.6	122.4
Ground Dove	3.9	2.0	50.8	5.9*	5.3	90.3
Honeyeater	1.4	2.1	143.3	1.3	4.4	331.7
Kingfisher	2.5	3.5	141.7	0.6*	1.1	173.0
Noddy Tern	0	0	0	0.4	1.3	331.7
P.T. Dove	32.4	22.7	70.0	26.4	15.0	56.7
Quail	2.8	8.2	296.8	0.2	0.6	3.3
Rail	6.9	5.1	72.9	2.3*	2.4	104.2
Rice Bird	17.8	23.9	134.3	33.7	60.1	178.3
Sparrow	24.5	25.5	104.3	22.8	23.9	105.0
Starling	11.7	9.5	81.5	6.8	8.1	119.2
White Tern	5.7	5.5	96.9	9.5*	15.4	162.4

Table 11. Population density values (birds/ha) of 12 native forest birds of Guam recorded weekly at 11 stations from October 1978 to October 1979.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	.12	0	0	.01	0	.04	0	.04	.04	0
Broadbill	0	.15	0	0	.15	.26	.16	1.13	1.34	.12	0
Crow	0	0	1.10	.37	.69	.84	.67	.57	.67	.82	.32
Fantail	0	0	0	0	2.74	5.46	2.64	10.28	9.62	2.06	0
Fruit Dove	0	.02	0	0	.03	.09	.48	.53	.58	.34	0
Ground Dove	0	.22	.79	.41	.44	1.39	1.20	1.01	1.05	7.89	.24
Honeyeater	0	.22	0	0	.66	2.04	2.64	2.80	.83	.92	0
Kingfisher	0	.74	.54	.61	.44	.93	1.71	1.19	.91	1.71	.09
Rail	0	21.27	0	1.65	2.03	.15	0	1.74	0	.16	.69
Starling	.47	2.52	.42	.75	6.30	7.07	5.40	9.94	8.26	9.05	.38
Swiftlet	0	0	0	0	0	0	0	0	2*	0	0
White-eye	0	0	0	0	16.02	.26	0	9.66	6.27	0	0
No. of Counts Per Station	22	45	19	74	46	47	70	67	44	21	21

* Only two swiftlets were observed. Consequently, a detection area could not be calculated for this species.

Table 12. Population density values (birds/ha) of 12 native forest birds of Guam recorded at 11 stations from October 1979 to October 1980.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	.04	0	0	0	.04	.13	0	0	.14	0
Broadbill	0	0	0	0	.63	.47	.16	1.88	.52	0	0
Crow	0	0	.46	.46	.82	1.18	.67	1.08	.91	2.35	0
Fantail	0	0	0	0	3.20	3.20	1.37	12.36	5.54	.46	0
Fruit Dove	0	0	0	0	0	.09	.17	.60	.62	.04	0
Ground Dove	0	.05	0	0	.92	.92	.46	1.37	.50	5.49	0
Honeyeater	0	0	0	0	0	3.66	4.12	5.03	2.01	.92	.46
Kingfisher	0	.21	0	.59	.67	.84	.59	.76	1.02	1.10	0
Rail	0	15.99	0	2.62	1.96	0	0	0	0	0	0
Starling	0	0	.24	.24	6.23	7.91	7.19	10.55	2.50	6.72	0
Swiftlet	0	0	0	0	0	0	0	0	0	0	0
White-eye	0	0	0	0	4.43	0	1.11	12.18	1.22	0	0
No. of Counts Per Station	10	9	11	11	11	11	11	11	10	11	11

Table 13. Average population density values (birds/ha) of each species during quarterly periods.

	FY 1979				FY 1980			
Species	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Aug	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Aug
Bittern	.01	.004	.03	.02	0	.10	.04	0
Broadbill	.73	.73	.23	.62	.43	.17	.63	.43
Crow	.53	.47	.39	.75	.57	.82	.64	.35
Fantail	4.44	4.54	4.05	3.08	1.73	1.46	2.97	2.20
Fruit Dove	.11	.27	.35	.22	.12	.02	.20	.24
Ground Dove	.34	1.48	2.49	1.42	.79	.81	1.60	.94
Honeyeater	.26	1.23	1.51	1.24	1.57	1.14	1.14	2.05
Kingfisher	.69	.93	.98	.83	.29	.72	.59	.61
Rail	2.24	3.25	3.04	2.69	2.71	.65	.67	2.25
Starling	5.74	6.59	4.84	4.66	3.95	4.68	4.31	5.11
Swiftlet	0	0	0	0	2*	0	0	0
White-eye	3.65	5.67	3.64	2.87	.76	3.14	2.22	1.14
No. of Counts Per Station	135	102	97	142	31	22	32	32

* Only two swiftlets were observed. Consequently, population density could not be determined.

Table 14. Species Incidence of 12 native birds of Guam recorded monthly at 11 stations from October 1978 to October 1979. Species Incidence = The number of birds of a species recorded, divided by the number of count periods during which the species was recorded.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	1.56	0	0	1.0	0	1.0	0	1.0	1.0	0
Broadbill	0	1.0	0	0	1.0	1.0	1.0	1.24	1.30	1.0	0
Crow	0	0	2.85	1.37	2.0	2.06	2.08	1.58	1.58	2.21	2.4
Fantail	0	0	0	0	1.04	1.21	1.0	2.23	1.94	1.20	0
Fruit Dove	0	1.0	0	0	1.0	1.13	1.17	1.48	1.65	1.44	0
Ground Dove	0	1.0	1.10	1.0	1.0	1.30	1.25	1.08	1.27	2.38	1.0
Honeyeater	0	1.10	0	0	1.0	1.06	1.0	1.15	1.22	1.0	0
Kingfisher	0	1.16	1.10	1.17	1.47	1.31	1.23	1.76	1.32	1.93	1.0
Rail	0	3.02	0	1.55	1.44	1.00	0	1.21	0	1.0	1.0
Starling	1.3	2.26	1.50	1.05	2.62	2.68	2.26	3.83	3.50	3.53	1.0
Swiftlet	0	0	0	0	0	0	0	0	0	0	0
White-eye	0	0	0	0	3.36	2.0	0	2.47	1.92	0	0
No. of Counts Per Station	22	45	19	74	46	47	21	70	67	44	21

Table 15. Species Frequency of 12 native forest birds of Guam recorded monthly at 11 stations from October 1978 to October 1979. Species Frequency = The number of count periods during which species was recorded divided by total number of count periods.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	.20	0	0	.02	0	.10	0	.01	.11	0
Broadbill	0	.09	0	0	.09	.15	.10	.53	.60	.07	0
Crow	0	0	.68	.47	.61	.72	.57	.64	.75	.66	.24
Fantail	0	0	0	0	.52	.89	.52	.91	.99	.34	0
Fruit Dove	0	.04	0	0	.07	.17	.86	.74	.73	.50	0
Ground Dove	0	.04	.16	.08	.09	.21	.19	.19	.16	.66	.05
Honeyeater	0	.04	0	0	.13	.38	.52	.49	.13	.18	0
Kingfisher	0	.69	.53	.57	.33	.77	.62	.73	.75	.95	.10
Rail	0	.98	0	.15	.20	.02	0	.20	0	.02	.10
Starling	.14	.42	.11	.27	.91	1.0	.90	.99	.90	.98	.14
Swiftlet	0	0	0	0	0	0	0	0	0	0	0
White-eye	0	0	0	0	.78	.02	0	.64	.54	0	0
No. of Counts Per Station	22	45	19	74	46	47	21	70	67	44	21

Table 16. Relative Abundance of 12 native forest birds of Guam recorded monthly at 11 stations from October 1978 to October 1979. Relative Abundance = The number of birds of a species recorded, divided by the number of the most abundant species recorded during the same count periods.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	.11	0	0	.01	0	.05	0	.05	.03	0
Broadbill	0	.03	0	0	.03	.06	.05	.17	.25	.02	0
Crow	0	0	1.0	.98	.46	.56	.58	.27	.38	.42	1.0
Fantail	0	0	0	0	.21	.40	.26	.54	.61	.12	0
Fruit Dove	0	.02	0	0	.02	.07	.49	.29	.39	.20	0
Ground Dove	0	.02	.08	.12	.03	.10	.12	.05	.07	.46	.08
Honeyeater	0	.02	0	0	.05	.15	.26	.15	.05	.05	0
Kingfisher	0	.27	.30	1.0	.18	.37	.37	.34	.31	.54	.17
Rail	0	.62	0	.35	.11	.0	0	.06	0	.01	.17
Starling	1.0	1.0	.08	.43	.91	1.0	1.0	1.0	1.0	1.0	.20
Swiftlet	0	0	0	0	0	0	0	0	0	0	0
White-eye	0	0	0	0	1.0	.02	0	.42	.33	0	0
No. of Counts Per Station	22	45	19	74	46	47	21	70	67	44	21

Table 17. Species Incidence of 12 native forest birds of Guam recorded monthly at 11 stations from October 1979 to October 1980. Species Incidence = The number of birds of a species recorded, divided by the number of count periods during which the species was recorded.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	1.0	0	0	0	1.0	2.0	0	0	2.0	0
Broadbill	0	0	0	0	1.0	1.5	1.0	1.5	1.5	0	0
Crow	0	0	2.25	1.8	1.78	2.88	1.86	2.30	2.29	1.67	0
Fantail	0	0	0	0	1.17	1.0	1.0	2.70	1.57	1.0	0
Fruit Dove	0	0	0	0	0	1.0	1.0	1.75	1.63	1.0	0
Ground Dove	0	1.0	0	0	1.0	1.0	1.0	1.0	1.0	1.50	1.0
Honeyeater	0	0	0	0	0	1.13	1.29	1.10	1.0	2.0	0
Kingfisher	0	1.0	0	1.4	1.60	1.20	1.17	1.80	1.38	1.86	0
Rail	0	2.86	0	1.0	1.0	0	0	0	0	0	0
Starling	0	1.0	1.0	1.0	2.36	3.0	2.73	4.0	3.0	2.0	0
Swiftlet	0	0	0	0	0	0	0	0	2.0	0	0
White-eye	0	0	0	0	1.60	0	2.0	2.75	2.0	0	0
No. of Counts Per Station	10	9	11	11	11	11	11	11	10	11	11

Table 18. Species Frequency of 12 native forest birds of Guam recorded monthly at 11 stations from October 1979 to October 1980. Species Frequency = The number of count periods during which a species was recorded, divided by the total number of count periods.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	.11	0	0	0	.09	.18	0	0	.18	0
Broadbill	0	0	0	0	.36	.18	.09	.73	.20	0	0
Crow	0	0	.36	.45	.82	.73	.64	.82	.70	.82	0
Fantail	0	0	0	0	.55	.64	.27	.91	.70	.09	0
Fruit Dove	0	0	0	0	0	.18	.36	.73	.80	.09	0
Ground Dove	0	.11	0	0	.18	.18	.09	.27	.10	.73	.09
Honeyeater	0	0	0	0	0	.73	.64	.91	.40	.09	0
Kingfisher	0	.22	0	.45	.45	.91	.55	.45	.80	.64	0
Rail	0	.78	0	.36	.27	0	0	0	0	0	0
Starling	0	.11	.09	.09	1.0	1.0	1.0	1.0	.90	.91	0
Swiftlet	0	0	0	0	0	0	0	0	0	0	0
White-eye	0	0	0	0	.45	0	.09	.73	.10	0	0
No. of Counts Per Station	10	9	11	11	11	11	11	11	10	11	11

Table 19. Relative Abundance of 12 native forest birds of Guam recorded monthly at 11 stations from October 1979 to October 1980. Relative Abundance = The number of birds of a species recorded, divided by the number of count periods during which the species was recorded.

Species	Tolang	Anderson South	Lajuna	Anao	Pati	Tarague	North-west Field	Ritidian	Uruno	Haputo	Two Lover's Point
Bittern	0	.05	0	0	0	.03	.13	0	0	.14	0
Broadbill	0	0	0	0	.15	.09	.03	.27	.11	0	0
Crow	0	0	1.0	1.0	.62	.70	.43	.48	.59	.54	0
Fantail	0	0	0	0	.27	.21	.10	.61	.41	.04	0
Fruit Dove	0	0	0	0	0	.06	.13	.32	.48	.04	0
Ground Dove	0	.05	0	0	.08	.06	.03	.07	.04	.43	1.0
Honeyeater	0	0	0	0	0	.27	.30	.25	.15	.07	0
Kingfisher	0	.10	0	.78	.31	.36	.23	.20	.41	.46	0
Rail	0	1.0	0	.44	.12	0	0	0	0	0	0
Starling	0	.05	.11	.11	1.0	1.0	1.0	1.0	1.0	1.0	0
Swiftlet	0	0	0	0	0	0	0	0	.07	0	0
White-eye	0	0	0	0	.31	0	.07	.50	.07	0	0
No. of Counts Per Station	10	9	11	11	11	11	11	11	10	11	11

Table 20. Comparison between 8 and 15 minute counts of 12 native bird species of Guam recorded at 11 stations from October 1978 to October 1980. A Mann-Whitney U-test showed no significant difference ($P > .20$) between the two count periods.

	TOTAL NUMBER OF BIRDS	
SPECIES	8 Minute Counts	15 Minute Counts
Bittern	18	29
Broadbill	118	169
Crow	383	558
Fantail	326	403
Fruit Dove	222	278
Ground Dove	107	142
Honeyeater	79	130
Kingfisher	351	487
Rail	154	199
Starling	021	1265
White-eye	232	346
Swiftlet	1	2

White-throated Ground Dove - Gallicolumba x. xanthura

The North and North-West Field roadside counts recorded significant ($P<.05$) increases in ground dove population, as opposed to the significant ($P<.05$) decrease found along the North-Central route. Population numbers have fluctuated widely over the last 6 years of roadside counts, perhaps owing to this bird's sometimes secretive nature. The majority of station counts indicated a decline in ground dove numbers, with Haputo containing the highest dove density. Population numbers still appear to be extremely low throughout its limited range.

Marianas Fruit Dove - Ptilinopus roseicapilla

Northwest Field and North roadside counts recorded significant ($P<.05$) increases in fruit dove population from the previous year, however population numbers still appear critically low in comparison with data from 1976 and 1977 (DAWR, 1979).

Pati, Northwest Field and Haputo station counts indicated declines in fruit dove densities. Slight increases in both densities and population numbers were observed at Ritidian and Uruno, however, fruit dove densities in all areas appear lowest in comparison with all other species of birds. Peak density values were recorded from April through September, perhaps indicating increased breeding activity, although Jenkins (1981) noted no seasonality for this species on Guam.

Vanikoro Swiftlet - Aerodramus vanikorensis bartschi

Swiftlets were last observed nesting in northern Guam during June, 1976 (Drahos, 1977) and no roadside counts have recorded this species since that date. One swiftlet was observed along the northern clifflines in 1978 and a total of 19 birds were observed foraging in the north during 1979. Two birds were observed at the Uruno station count in 1980.

Periodic surveys in 1980 of known swiftlet foraging areas in the south recorded a maximum of 24 birds in each of two areas. Searches for active swiftlet caves in Talofofo and the Naval Magazine were unsuccessful. From had an estimated population of 3 to 4,000 birds in 1962 (Drahos, 1977) but total swiftlet numbers on Guam now appear to be less than 100. Rota Island has also experienced a severe drop in swiftlet population and no birds have been observed since 1978 (Pratt, et al. 1979). A thriving population of this species, however, exists throughout the Palau Islands (Pratt, et al. 1980).

Guano and tissue samples of the swiftlet have contained DDE and DDT (Drahos, 1977). Detrimental levels are unknown for this insectivore and results are difficult to interpret. Causes for endangerment and a recovery program need to be determined quickly for the swiftlet if extirpation on Guam is to be avoided.

Micronesian Kingfisher - Halcyon c. cinnamomina

The North and North-Central roadside counts showed significant ($P<.05$) decreases in numbers of kingfishers observed, continuing a steady population decline since 1976. While population numbers appear extremely low throughout their restricted range, this species did show a statiscally significant ($P<.05$) increase over the Northwest Field route, an area consistantly showing the highest kingfisher numbers.

Station counts showed a drop in kingfisher densities at 10 stations over the past year. Density peaks occurred during the first and 2nd quarters, supporting Jenkins (1981) assertion of reduced or absent kingfisher breeding during the 3rd and 4th quarters of any year.

Marianas Crow - *Corvus kubaryi*

The Northwest Field roadside counts showed a significant ($P<.05$) decrease in crow population numbers over the last year, although remaining fairly consistant with numbers recorded in this area since 1974. Continuing a general decline since 1976, no crows were recorded on any North-Central roadside counts and numbers of crows on the northern route appeared so small as to make comparisons between FY 1979 and 1980 meaningless.

Crow densities fluctuated substantially between stations as well as between years, possibly reflecting this specie's high mobility. Density values for the 9 stations at which crows were observed were among the lowest recorded for any species. First and third quarter counts indicated higher average crow densities, possibly conflicting with Jenkin's (1981) indications of year-round breeding. Clearly, the crow population on Guam is at a critical level.

Guam Broadbill - *Myiagra freycineti*

Guam's endemic broadbill was not observed during any roadside count over the past 6 years. Its sedentary habits and small size may make its detection difficult from a moving vehicle (Jenkins, 1981).

Broadbills are more easily observed from station counts, their loud calls accounting for the largest detection area of any passerine censused (Table 1). Despite their conspicious calls, broadbills showed the lowest relative abundance and the lowest density of any native passerine during comparable station counts. Relative broadbill densities remained highest at Tarague and Pati and Ritidian Points, showing a slight increase in population over FY 1979. No significant ($P>.20$) difference was found between overall broadbill densities for FY 1979 and FY 1980. As the Guam broadbill is the only member of its genus to be found in the Marianas, its continued low population level is cause for concern.

Rufous-fronted Fantail - *Rhipidura rufifrons uraniae*

North-Central and North roadside counts showed significant ($P<.05$) reductions in fantail numbers in FY 1980, reflecting a general downward trend in this specie's numbers since 1976. Northwest Field showed a non-significant increase in numbers and appears to hold one of the greatest concentration of fantails. Fantail densities determined through station counts were recorded to be the highest of any species at Ritidian and Uruno Points, with densities decreasing rapidly to the east and south. Only pristine limestone forest still appears to hold reasonable populations of fantails on Guam.

Micronesian Starling - *Aplonis opacus guami*

The Northwest Field roadside counts showed a significant ($P<.05$) increase in starling population numbers, while the more disturbed North-Central route recorded a significant ($P<.05$) decrease. Population numbers, as a whole, remained fairly constant during FY 1980.

Undoubtedly the most abundant of native forest bird species, starling population densities increased at stations in the North-West and remained fairly stable in other areas. In addition, the starling population on Cocos Island appears small but viable; the Cocos Island starlings are apparently the only native forest bird species still regularly reproducing in southern Guam.

Cardinal Honeyeater - *Myzomela cardinalis*

The North-Central roadside counts recorded a significant decrease in honeyeater population numbers between FY 1979 and FY 1980. North and Northwest Field routes also showed a similar, but non-significant decline, continuing the precipitous decrease in honeyeater numbers since 1977. This decline becomes more dramatic in comparison with Rota Island's thriving honeyeater populaton, where this species is commonly observed in residential gardens as well as pristine forests (Jenkins and Aguon, 1980). Station counts in 1980 indicated slight increases in densities along the north-western forests of Guam. Population estimates are still well below fantail numbers. Ritidian and Northwest Field, with their abundant coconut trees providing necessary nectar, may well be the last stronghold for honeyeaters left on Guam.

Bridled White-eye - *Zosterops c. conspicillatus*

A small inconspicuous species, white-eyes were not observed during any roadside counts in 1980. Station counts recorded white-eyes only at Pati, Tarague, Ritidian and Uruno points. Ritidian and Northwest Field showed increased densities in 1980 with other areas reporting decreasing numbers of this species. White-eyes were observed to have the highest density of any bird at Pati Point, however, this figure may be artificially high due to this species flocking characteristics.

White-eyes were similarly noted in extremely restricted areas on Rota, where population numbers have also appeared to decrease in recent years (Jenkins and Aguon, 1980). White-eye densities decreased in the fourth quarter of 1979 and1980, possibly indicating a lack of breeding during winter months as suggested by Baker (1951).

Studies in the Northern Marianas

Variable-circular plot counts were conducted in a variety of habitats on Saipan in January, 1980. Similar counts were done at 21 stations on Rota Island in July, 1980. Data are currently be analyzed to compare density values for each species in similar habitats on Guam. Initial figures show substantially higher populations numbers for all bird species in the Northern Mariana Islands in comparison with Guam's bird population.

Published Research

As part of a two-year study, former DAWR biologist J. Mark Jenkins completed a detailed paper entitled "Life Histories of the Native Birds of Guam" (Jenkins, 1981). It is currently in press as DAWR Technical Bulletin No. 5 and greatly increases our knowledge of Guam's avifauna.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts over three routes in northern Guam.
2. Continue station counts of the native forest birds and establish more stations including suburban, disturbed second-growth, and agricultural areas. Behavior, foraging activity, and other related observations should be included.
3. Continue to monitor the native forest birds of the Northern Mariana Islands for any trends in populations decline or increase, for comparison with bird populations on Guam.
4. Implement studies designed to investigate the causes of the decline in native forest bird populations on Guam.

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STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 4

JOB TITLE: Preparation of a "Field Guide to Guam Birds".

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

The job objectives were modified to include all common terrestrial wildlife into a "Field Guide to the Wildlife of Guam." Original objectives were partially fulfilled by the manuscript "Life Histories of the Native Forest Birds of Guam" (Jenkins, 1981). Field guide format has been chosen and photographs are being compiled. Completion is scheduled for 1981. A set of 20 wildlife brochures were completed with CZM funds for use by local school children.

BACKGROUND

With the publishing of Jenkin's "Life Histories of the Native Forest Birds of Guam" as Division of Aquatic and Willdife Resources' Technical Report No. 5, some of the objectives concerning a field guide to the birds of Guam were fulfilled. However, even though this and other status reports as well as a naturalist's guide have been written about the animals of Guam, no real field guide with photographs or paintings for identification exists specifically for Guam (Key, 1968; Jenkins, 1980a, 1980b, 1981; Wheeler and Aguon 1978; Wheeler, 1979). Such a field guide would fill this gap and provide educators and the interested public with easily accessible information vital to sparking a conservation ethic. To better meet the public's needs, the original format was changed to include mammals, reptiles, amphibians and selected invertebrates.

OBJECTIVE

To prepare a "Field Guide to the Wildlife of Guam".

PROCEDURES

1. Choose an acceptable field guide format and design.
2. Choose species to be represented in detail, with emphasis on common and endangered animals, and compile an appendix providing a complete list of terrestrial vertebrates and their status.
3. Synthesize existing data on status, description, life history, and habits.
4. Collect the necessary photographs of each species.

RESULTS

A suitable format for the field guide was chosen that will include an introduction, habitat description, text, appendix and index. The introduction will contain a brief geological history of the island, and a discussion of the various means by which wildlife arrived and the uniqueness of Guam's fauna.

The section on habitat will include a representative photograph of each of the 7 major habitat types, a short description and a map illustrating where these areas may be found on Guam.

The text is to be separated by classes of animals, each section beginning with a complete class checklist, including each species' scientific name and status. Each species selected for greater detail will have a representative photograph and a short text discussing its status, description, life history, and the habitat in which it occurs. The English, Chamorro and Japanese common names will be given in addition to the scientific name. Species designated as candidates for listing on the Federal Endangered Species list will be indicated by a large red star. An index will complete the field guide. A total of 11 invertebrates, 9 amphibians and reptiles, 40 birds and 6 mammals have been selected for detailed descriptions and several portions of the text have been completed.

High quality photographs, particularly of Guam's more secretive forest species, have been difficult to obtain. Playback of recorded calls has helped collect several species' portraits and the photographic library needed is slowly growing. Outside photographers are being contacted for particularly rare photos.

A photographic portfolio of 20 common or endangered animals and their life histories was developed into 8" x 11½" wildlife brochures. These brochures, funded by the Guam Coastal Zone Management (CZM) Program, Bureau of Planning, Government of Guam, are being distributed to all elementary teachers on Guam and will help fill an educational gap until the field guide is completed. It now planned that publication costs for the field guide will be charged to our CZM public information program.

RECOMMENDATIONS

1. Complete collection of necessary photographs.
2. Complete species descriptions and compile into a finished manuscript, to be published with funding obtained by the Guam Coastal Zone Management Program.

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Report prepared by: Anne F. Maben

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 1 Recovery and Management of Marianas Fruit Bats in the Mariana Islands

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Literature Search and Bibliography on *Pteropus* sp.

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To conduct a literature search and compile a selected bibliography on the genus *Pteropus*.

PROCEDURES

1. Purchase, or otherwise acquire, computer searches of literature on *Pteropus* spp. from government and commercial sources.
2. Search *Wildlife Review* and current periodicals.
3. Acquire reprints or photocopies of pertinent literature.

RESULTS

This job was completed during the segment and the final report published as:

> Wheeler, Michael E. 1979. A bibliography of the fruit bat genus *Pteropus*. Technical Publication No. 4. Division of Aquatic and Wildlife Resources. Agana, Guam.

This report included, as an appendix, a key to fruit bat species commonly imported to Guam for food.

RECOMMENDATIONS

Discontinue this job but continue to acquire pertinent literature on *Pteropus* under the other fruit bat jobs.

Report Prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: The Current Status, Distribution and Natural History of Marianas Fruit Bats

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

The major effort during the reporting period was to conduct a study correlating fruiting phenology to fruit bat abundance. Other activities include periodic monitoring of bat distribution and density, monitoring of fruit bat imports, and bat surveys on Rota, Tinian and Saipan.

BACKGROUND

The Marianas fruit bat (*Pteropus mariannus mariannus*) is endemic to the Mariana Islands and is now considered endangered on Guam. This species has been proposed for endangered status under the Endangered Species Act of 1973 and positive action is expected in 1981. The Marianas fruit bat, considered a delicacy among the indigenous people, has been under investigation by the Aquatic and Wildlife Resources Division (AWR) of Guam since 1962 (A.W.R. 1964-1978). These investigations documented a steady decline in a population index throughout the 1960's (Perez 1972, 1973). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies numbering in the hundreds (Wheeler and Aguon 1978, Wheeler 1979a). Reasons for the decline include: increased human population pressures resulting in over-hunting and permanent habitat loss, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislatures in passing protective legislation (Wheeler 1979a).

OBJECTIVES

To monitor the current status and distribution of Marianas Fruit bat populations in the Mariana Islands.

PROCEDURES

1. Continue the systematic survey of Fruit Bat distribution and numbers started on Guam in 1978 and on Saipan, Tinian and Rota in 1979.
    a. Conduct bi-weekly surveys at five location on Guam, with periodic surveys in other areas.
        1. Record bat numbers observed.
        2. For each bat observed record (where possible and applicable); flight elevation and direction; roosting tree species and height; part of plant eaten (flower fruit, seeds, leaves, etc.); height in forage tree; sex and age (if possible); other behavior such as vocalization, population, etc.
    b. Conduct annual surveys on Rota, Tinian and Saipan.
2. Monitor fruit bat imports from the Northern Marianas and other island groups.
    a. Compare import permits issued in past and current years with the actual number of bats imported.
3. Maintain close liaison with other bat researchers and with government officials in other island groups as well as on Guam.

RESULTS

Survey and Natural History

The bulk of the fieldwork under this job during this segment was directed toward conducting a study of the relationship of fruiting phenology to fruit bat abundance. The results of this study were compiled into the following manuscript:

> Wheeler, M.E. 1980. Fruit bat abundance, phenology of fruiting, and interspecific associations in the limestone forests of Guam. Division of Aquatic and Wildlife Resources. Agana, Guam (Unpublished Manuscript).

This manuscript is reproduced in its entirety in Appendix I.

Regular surveys of Guam's bat population ended in June, 1980, when Michael E. Wheeler left Guam at the end of his contract. Spot checks of the Pati Point roosting colony were made throughout the remainder of the segment. The colony continued to roost at Pati Point and numbered at least 200 bats at the end of the segment.

Northern Marianas

Surveys of Saipan and Tinian were conducted in January, and of Rota in July, 1980. Methodology was similar to that described by Wheeler (1980). On Saipan, approximately 613 hectares were surveyed in 9.83 man-hours of observation and no bats were seen. On Tinian, 341 hectares were surveyed in 11.25 man-hours of observation and seven bats were observed. On Rota, approximately 13 man-hours of observation over 380 hectares resulted in sightings of approximately 50 bats.

On both Tinian and Rota time was spent in the company of bat hunters who agreed to assist in locating bats. In addition to actual field assistance, these individuals provided much information about the biology and behavior of bats. On a positve note, the bat hunter on Rota who provided assistance has somewhat of a conservation ethic, as he maintains that he will not hunt bats at colonial roosting sites for fear of causing them to abandon the site. He claims to have made efforts to persuade other hunters to do the same. There is evidence that indicates that bats will abandon colonial roositng sites when disturbed by shooting; disturbance of roosting colonies during the hunting season on Rota may be the cause of increases in bat numbers observed at Pati Point colony on Guam in January, 1979 and November, 1980.

Bat Imports

Fruit bats continued to be imported in large quantities for both personal consumption and retail sale, with by far the greatest number of bats coming from Palau and Yap. Import permits are requried for all shipments of bats to Guam; there is currently no limit to the number of bats that can be requested on a single permit and retail merchants frequently inflate their requests to cover the possibility that a large number of bats may be available at the supply source. Table 1 presents the total number of bats requested for import between July1, 1979 and September 30, 1980. This 15-month period includes the three-month transition period (July - September, 1979) that resulted when the Government of Guam changed from a July-June to a October-September fiscal year; these transition months are reported for the sake of continuity as import data previously reported terminated in June, 1979.

When bat shipments are processed through Customs, the import permit is signed by the Customs inspector and returned to the Department of Agriculture. Any discrepancy between the number of bats request on the permit and the actual number in the shipment is supposedly noted by the inspector on the permit. Table 2 presents the estimated number of bats imported to Guam over the same 15-month time period as Table 1. These figures are estimates because import permits for bat shipments received March through June, 1980 are missing; the figures given for these months were estimated based on the number of bats requested for importation that month and the percentage of requested bats imported during the rest of the year.

A questionaire survey of fruit bat importers started in FY 1979 was continued. Seventy fruit bat importers were asked to fill out a questionaire when they applied for import permits. The intent of this questionaire was to determine the economic benefits derived from importing fruit bats and to find out

Table 1. Numbers of frozen fruit bats requested for import to Guam between July 1, 1979 and September 30, 1980.

	FY 79 Transition			FY 1980												
Origin	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total
Saipan	377	522	267	306	272	442	315	135	111	320	357	1,230	631	792	386	6,463
Tinian	85	20				56		73	57	30	480	10		10	20	841
Rota		240	129	996	209	247	275	83	65	1	10				120	2,375
Yap	750	600	845	1,445	2,245	1,130	1,720	2,360	1,285	545	8,265	1,335	895	5,435	4,830	33,685
Palau	2,441	1,980	1,820	3,200	3,977	1,291	1,070	1,515	1,110	694	1,585	1,933	6,495	5,660	5,727	46,498
Ponape		1,300		2,500	50	400	600	1,000	650	75	3,000	35	2,930	2,500	1,500	16,540
Truk		50				200	20				28		25			323
Solomans																
American Samoa		100		5					24			100		500		729
Tonga	50															50
Fiji									25							25
Kosrae											100		100			200
Philippines															200	200
Ulithi							100				50					150
	3,703	4,812	3,061	8,452	6,753	3,766	4,100	5,166	3,327	1,665	19,875	4,643	11,076	14,897	12,783	108,079

Table 2. Numbers of frozen fruit bats imported to Guam between July 1, 1979 and September 30, 1980 according to import permits processed through Customs.

Origin	FY 79 Transition			FY 1980												
	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	*Mar	*Apr	*May	*Jun	July	Aug	Sept	Total
Saipan	190	270	70	40	11		60	20	30	87	97	335	215	168	10	1,603
Tinian	65								15	8	131	2		10		231
Rota		50	80	225	30	93	5	40	17		2				10	552
Yap	100	80		485	207	530	495		350	148	2,256	364	1,623	1,100	1,052	8,790
Palau	2,262	1,150	525	2,156	585	430	436		303	189	2,070	527	523	810	1,825	13,791
Ponape		400		200	50	400	200		177	20	819	9	1,150	500		3,925
Solomans																
American Samoa		7							6			27		500		540
Truk											76					76
Tonga																
Ulithi											13					13
Fiji								6								6
Kosrae											27					27
	2,617	1,957	675	3,106	883	1,453	1,196	66	*898	*452	*5,491	*1,264	3,511	3,088	2,897	29,554

*Estimate based on the number of bats requested for that month and the percentage of requested bats imported during rest of sample period.

other characteristics of the fruit bat trade. The results of the survey are presented in Table 3.

Personal consumption is by far the purpose for most import permits issued, with nearly 70% of the respondents citing this as their purpose. Nearly 8% cited "other" as their reasons for importing fruit bats, examination of their questionaires indicates that this generally means for a party, fiesta or some type of family gathering, all of which could be considered a form of personal consumption.

Nearly 22% indicated that their purpose involved the sale of bats either to friends, retail stores, or wholesalers. The average proposed selling price on Guam was $6.44 (Range $5-$10). Purchase price at point of origin ranged between $2 - $8, though 15% of the respondents indicated that they would acquire the bats free of charge from friends or relatives.

RECOMMENDATIONS

1. Continue the bat monitoring study and collection of ecological and life history on Guam. Expand this study to include telemetry studies of fruit bat movement and activity patterns, and studies of the reproductive biology of the Marianas fruit bat.

2. Continue to survey fruit bat numbers and distribution on Rota, Tinian and Saipan at least once and preferably twice a year. These surveys should continue until the Commonwealth ofthe Northern Marianas has established a wildlife management program.

3. Continue to monitor fruit bat imports and work to implement regulations controlling the trade in fruit bats. Suggested regulations would prohibit the importation of *P. mariannus* and place quotas on the importation of other species. In addition, export permits or certificates of origin should be required for all shipments of fruit bats entering Guam to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their resources.

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Table 3. Characteristics of fruit bat importers

Purposes for Importing	No. Response	Percent
Personal consumption	53	69.7
For sale to funds	10	13.2
For sale to a retail store	5	6.6
For sale to a wholesaler	2	2.6
Other	6	7.9

Maximum Cost of Bats at Origin	No. Response	Man-Cost ($U.S.)	Range ($U.S.)
Palau	9	3.85	$2.00-$8.00
Yap	8	3.88	2.00- 7.00
Saipan	2	7.50	5.00-10.00
Tinian	1	7.00	5.00- 8.00

Selling Price on Guam (N=7): Mean = 6.44; Range $5-$10.

Frequency of Importing	No. Responses	Percent
Less often than once a year	32	52.5
Once very 6 to 12 months	9	14.8
More often than once a month	7	11.5
Once every 3 to 6 months	6	9.8
Once every 1 to 3 months	7	11.5

Ethnic Affiliation	No. Responses	Percent
Chamorro	35	51.5
Palauan	16	23.5
Yapese	6	8.8
Caucasion	7	10.3
Chinese	2	2.9
Filipino	1	1.5
Other	1	1.5

Wheeler, M.E. and C.F. Aguon. 1978. The status and distribution of the Marianas fruit bat on Guam. Division of Aquatic and Wildlife Resources Technical Report No.1. Department of Agriculture, Box 23367, G.M.F., Guam, M.I. 29p.

Report Prepared by Robert D. Anderson

Marianas fruit bat

Appendix 1

Fruit Bat Abundance, Phenology of Fruiting and Interspecific Association in the Limestone Forest on Guam

By

Michael E. Wheeler

Fruit Bat Abundance, Phenology Of Fruiting, And Interspecific Associatons In The Limestone Forest Of Guam

by
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INTRODUCTION

The taxonomy of Guam's flora has been well documented and several vegetation types have been proposed (Fosberg 1960, Stone 1970). One of these types is forest of elevated hard limestones, also known as a typhoon forest because of the fact the frequent typhoons prevent this type from attaining a climax successional stage. Species composition and several vegetational communities have been described for this limestone forest type, (Moore 1973, Muniappan 1976). To date, however, there has been no quantitative accounting of the phenology of fruit production in the limestone forest. Such forests are of considerable importance to the native terrestrial vertebrate fauna of Guam. A wide diversity and great abundance of fruiting and flowering plants provide food and cover for the Marianas fruit bat (*Pteropus mariannus*), the little Marianas fruit bat (*Pteropus tokudae*), the Marianas fruit dove (*Ptilinopus roseicapillus*), the white-throated ground dove (*Gallicolumba xanthonura*), the Marianas crow (*Corvus kubaryi*), and the Micronesian starling, (*Aplonis oparus*). This vegetation type also represents the major portion of habitat occupied by Micronesian kingfishers (*Halcyon c. cinnamomina*), Guam flycatchers (*Myiagra freycineti*), rufous-fronted fantails (*Rhipidura rufifrons uraniae*), bridled white-eyes (*Zosterops c. conspicillata*), and cardinal honeyeaters (*Myzomela cardinalis saffordi*).

In spite of the dependence of frugivorous bats and birds on the limestone forest type and the near restriction of other rare bird species to this habitat, there are very little quantitative data available regarding the food resources to be found there. The purposes of this study were: to document monthly changes in the fruiting condition of a number of dominant plants of limestone forest in four separate areas on Guam; to monitor fruit bat utilization within the same areas; to attempt to correlate various parameters of the phenology of fruiting with the observed abundance of and utilization by fruit bats; to monitor the abundance of frugivorous and omnivorous avifauna utilizing the limestone forest areas and determine if any significant associations occur between fruit bats and fruit-eating birds. Additionally, data on the occurrence of other rare native birds were collected and analyzed.

CLIMATE AND SEASONS

The climate is tropical and the weather is warm and humid regardless of the time of year. There are, however, two seasons: a wet season (July to November) during which 63-66% of the annual rain falls, and a dry season (January to May) during which 20-24% of the annual rain (about 80 inches) falls. The relative humidity is commonly in the range of 80-90% and daytime temperatures are usually between 80°F and 88°F (Moore and McMakin 1977, Tenorio et al. 1979).

METHODS

Two 1km transects were established at each of the following areas: Naval Communications Station, Ritidian Point, Tarague, and Pati Point (Fig. 1). Transects made use of available trails and roads. One transect was located on the upper plateau and the other was located on the terrace. After establishing familiarity with the plants of each area and consulting the available literature (Stone 1970, Moore 1973, Muniappan 1976) the following list of dominant trees and shrubs was made, as time constraints made it impossible to considerall species in this incredibly diverse forest type:

Artocarpus mariannensis
Pandanus frangrans
Neisosperma oppositifolia
Aglaia mariannensis
Permna obtusifolia
Guamia mariannae
Carica papaya
Eugenia reinwardtiana
Ficus prolixa
Macaranga thompsonii
Cycas circinalis
Psychotria mariana
Melanolepis multigrandurosa
Elocarpus sphaericus
Piturus argenteus
Triphasia trifolia
Wikstromea elliptica
Cestrum diurnum
Morinda citrafolia
Ochrosia mariannensis

The fruiting condition (i.e. presence and number of fruits) of individual plants along the transects was noted. Data collection along each transect continued until at least 10 individuals of the 10 most common species on the list were encountered and their fruiting condition noted (see Appendix). The fruiting condition of individual plants of all other species on the list was also noted. Only mature plants were used for this study. The relative frequency of each species was determined by dividing the total number of individuals of the species encountered along the two transects in an area by the sum of all species encountered along the two transects. Data on relative frequency were collected one time only (April 1980). Data on fruiting condition were collected monthly from August 1979 to April 1980.

Correlation tests between parameters of the phenology of fruitng and fruit bat adundance. The following parameters were calculated:

Fruiting Frequency = Percentage of individuals of a given species in fruit for a given month divided by 100.

Aggregate Fruiting Plant Abundance Index = Sum of the product of the relative frequencies and the fruiting frequencies of all plants surveyed in given area for a given month.

Equally Common Fruiting Plants = A measure of diversity of fruiting plants that takes into consideration the relative frequency of each species and the fruiting frequency of that species for a given month; determined by the following formula (MacArthur 1964):

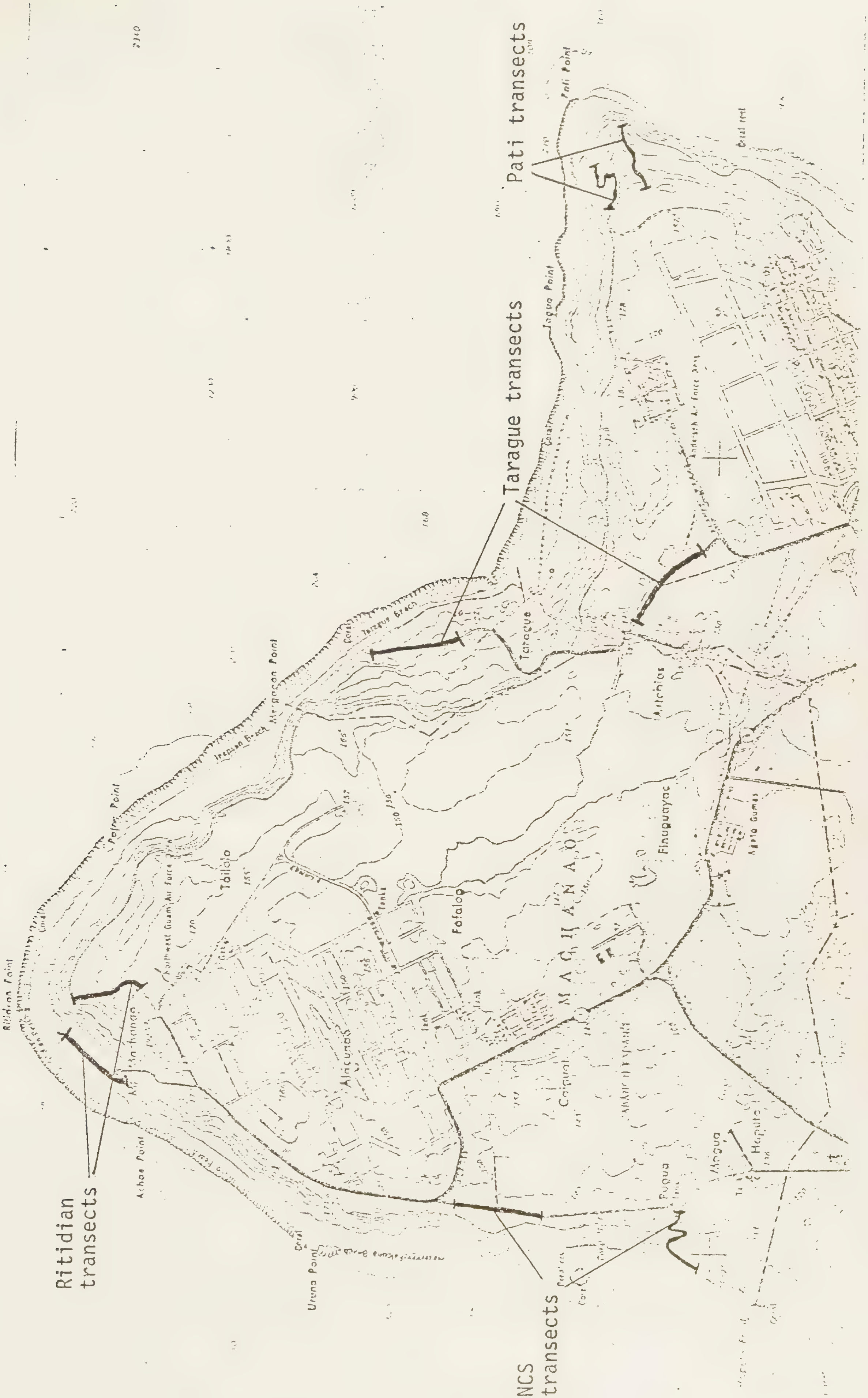
Ritidian transects
NCS transects
Taragaue transects
Pati transects
Ritidian Point
Achae Point
Uruno Point
Potts Point
Falcon Point
Taragaue Beach
Tarague
Jinapsan Beach
Mergagan Point
Pati Point
Jagua Point
Andersen Air Force Base
Northwest Guam Air Force Base
Tailalo
Fafalog
Machanao
Finaguayac
Achiblas
Aguja Gumes
Alicundas
Caigual
Pugua
Hapula
Magua
Coral

Figure 1. Phenology of fruiting transect locations.

$E = e^{H}$ Where $H = -\Sigma(p_i)\ (\ln p_i)$
and $p_i = ((rf_i)\ (ff_i))/\ \Sigma(rf_i)\ (ff_i)$
rf = relative frequency
ff = fruiting frequency

The phenology data were used to test the following null hypotheses:

1.) There is no correlation between the aggregate abundance of fruiting plants and the number of fruit bats observed utilizing and area.

2.) There is no correlation between the diversity of fruiting plants and the number of fruit bats observed utilizing an area.

3.) There is no correlation between the product of diversity and aggregate abundance and the number of fruit bats observed utilizing an area.

Data on fruit bat abundance were collected as described by Wheeler (1980), except that the Jinapsan Beach observation points were not used for this study.

Data on avian abundance and utilization of limestone forest were collected as described by Scott (ms), except that 15 minute station counts were used. These data were then analyzed as described in Reynolds et al. (ms) and Ramsey and Scott (in press) to determine avian densities. The concentric bands of the circular plots were increased by increments of 15.38 m for all species except the Marianas fruit dove and white-throated ground dove. Increments of 30.77 m were used for these two species.

RESULTS AND DISCUSSION

Fruiting Phenology. Temporal changes in fruiting condition of the twenty species of plants studied fit into four categories: perennial fruiters, not seasonally depressed; perennial fruiters, seasonally depressed; annual fruiters, for which all individuals produced no fruits for at least three consecutive months; and intermittent fruiters for which all individuals in one or more areas went out of fruit production for one or more months, but again started producing fruits during the nine month period. "Seasonally depressed" is operationally defined as having at least 40% change in the percentage of individuals in fruit in all areas studied over the period of study.

The following species fit into the category of perennial fruiters, not seasonally depressed: Langiti (*Ochrosia mariannensis*), papaya (*Carica papaya*), cycad (*Cycas circinalis*), and lada (*Morinda citrafolia*) (Fig. 2-5). Perennial fruiters that are seasonally depressed show two major trends. A number of species exhibit a decrease in fruit production during the months of December through March. These include: pengua (*Macaranga thompsonii*), alom (*Melanolepis multigrandulosa*), aplokuting (*Psychotria mariana*), and amahadyan (*Pipturus argenteus*) (Fig. 6-9). Other species exhibited depressed fruiting sometime between August and December. These include: screwpine (*Pandanus frangrans*), fago (*Neisosperma oppositifolia*) ahgao (*Premna obtusifolia*), and inkberry

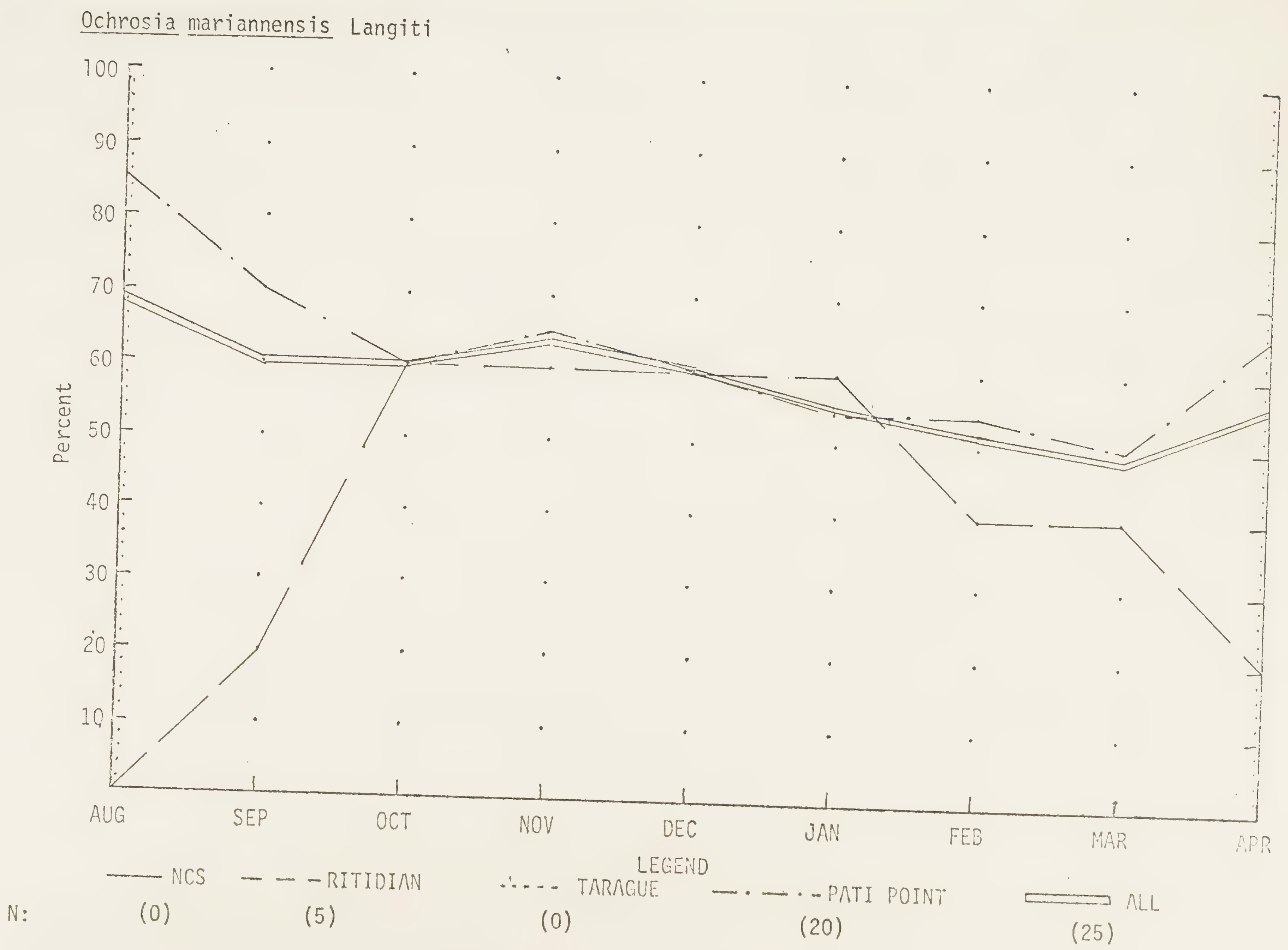

Figure 2. Percentage of _Ochrosia mariannensis_ in fruiting condition.

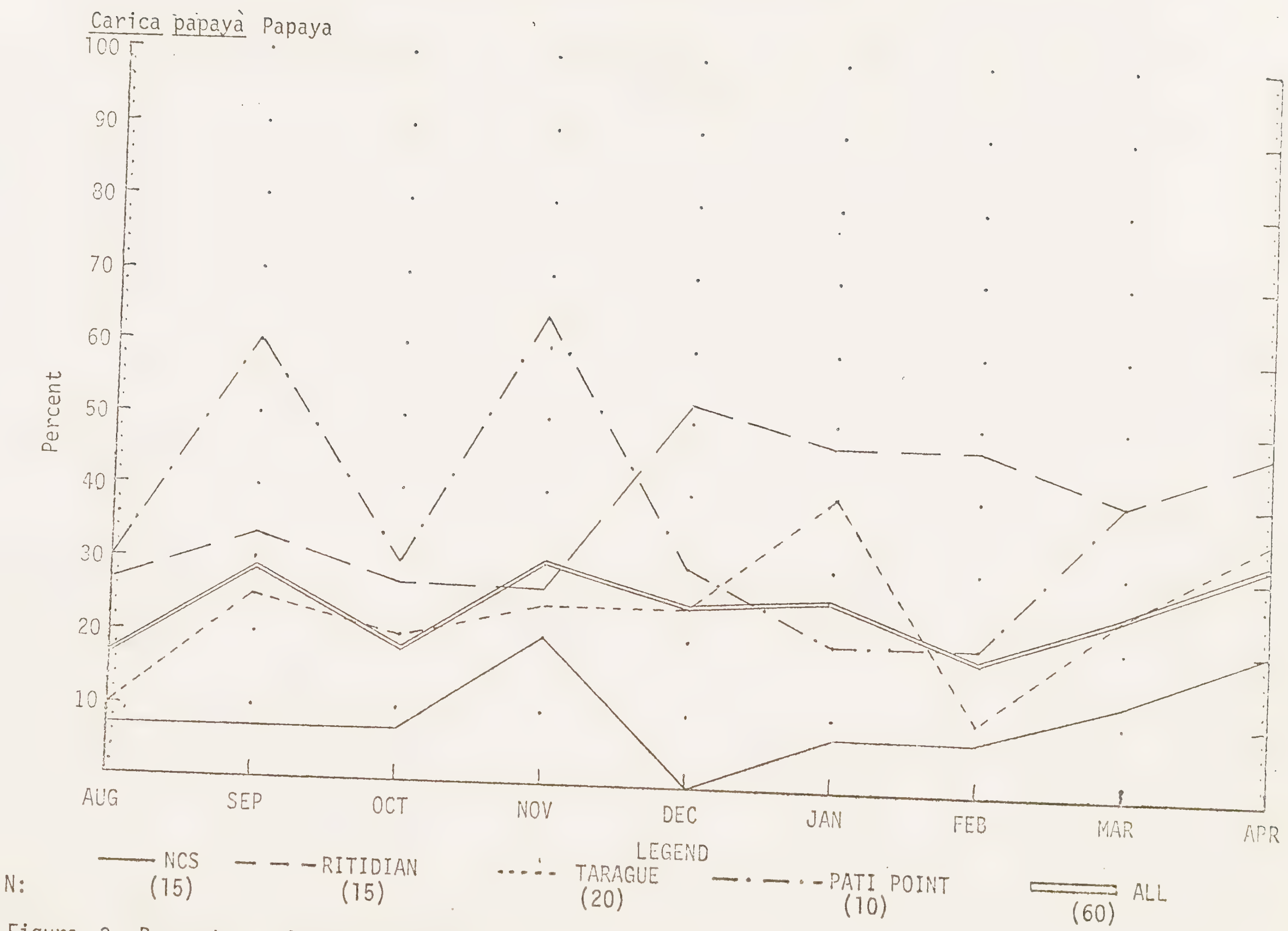

Figure 3. Percentage of *Carica papaya* in fruiting condition.

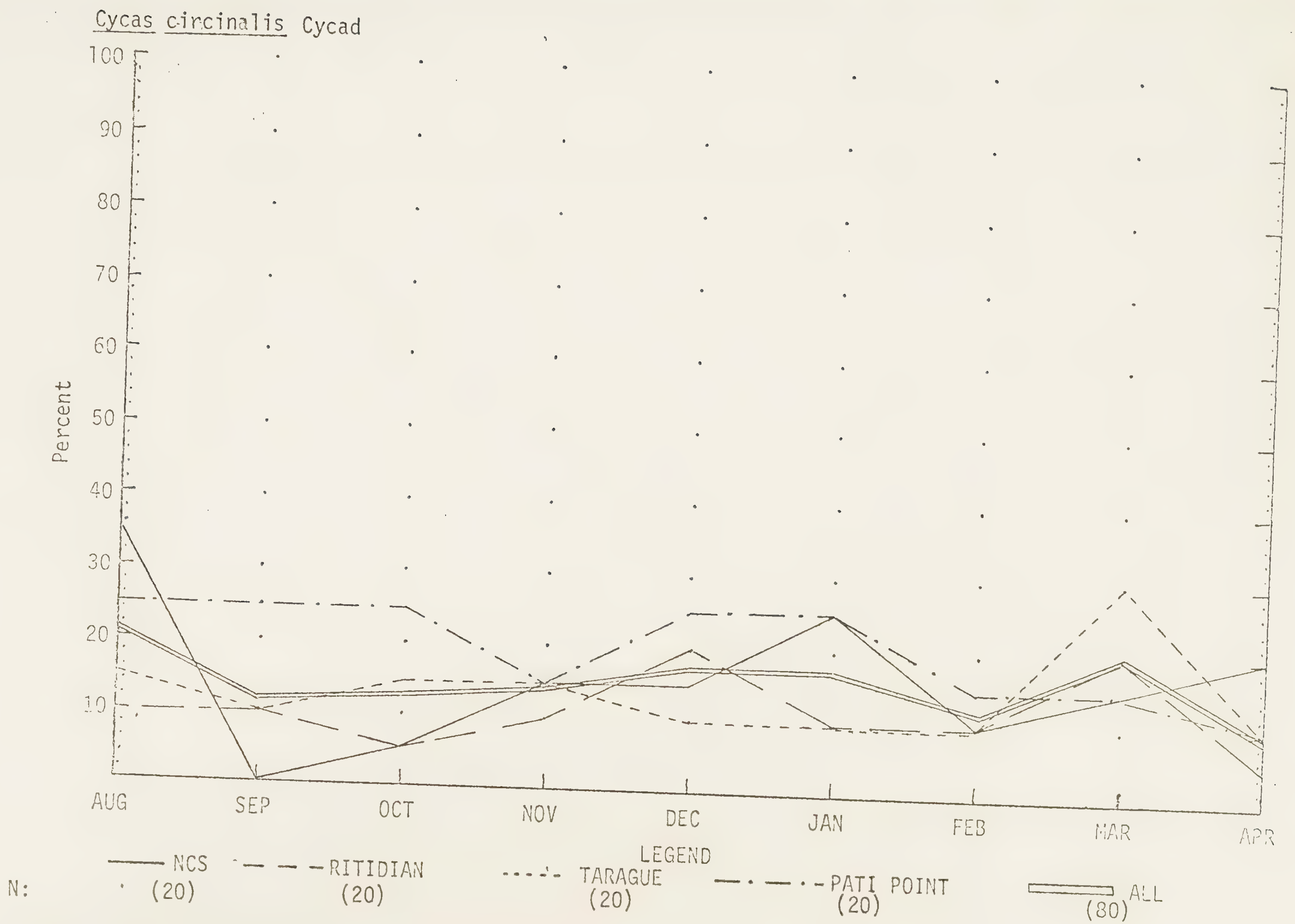

Figure 4 . Percentage of Cycas circinalis in fruiting condition.

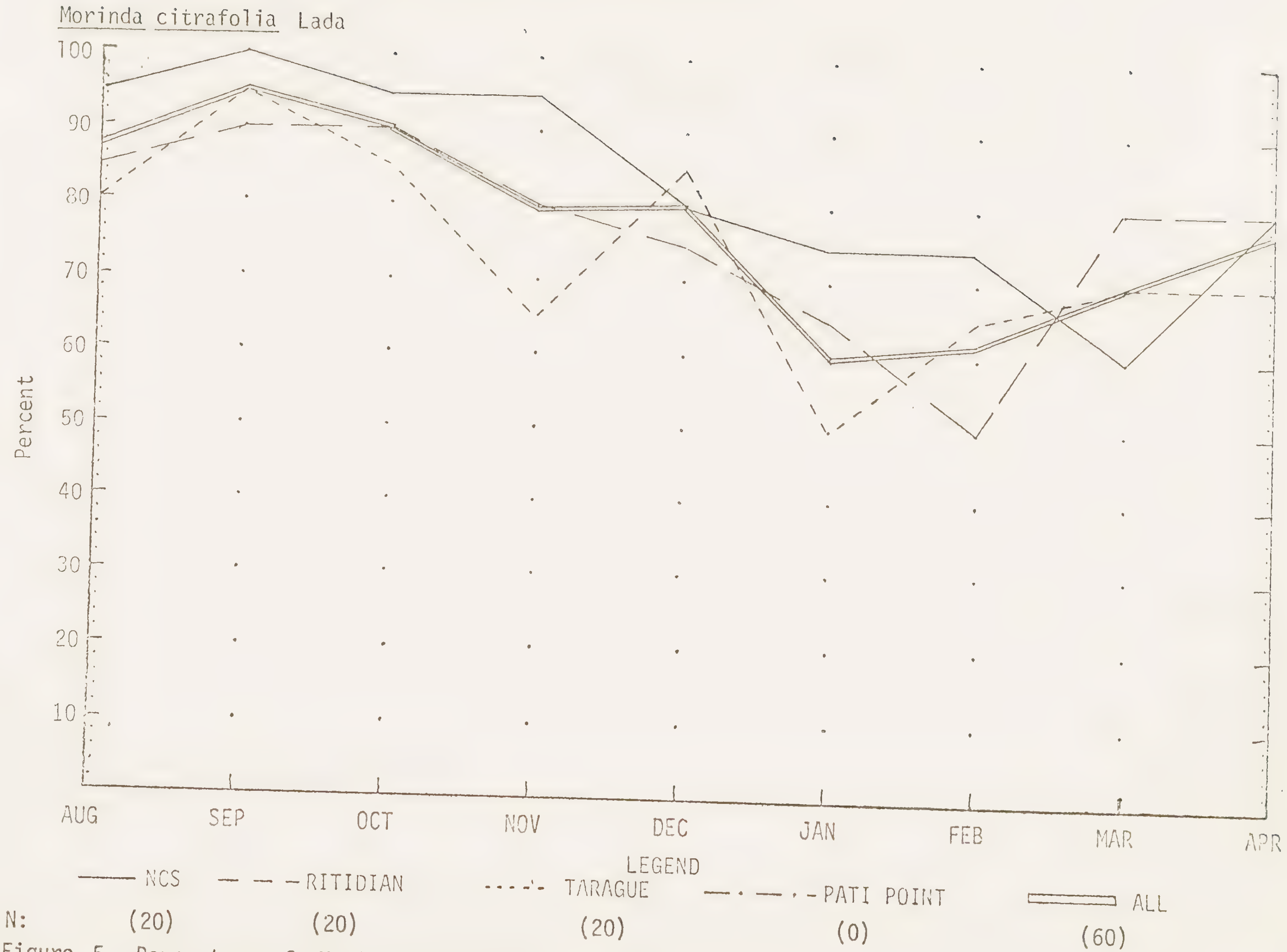

Figure 5. Percentage of *Morinda citrafolia* in fruiting condition.

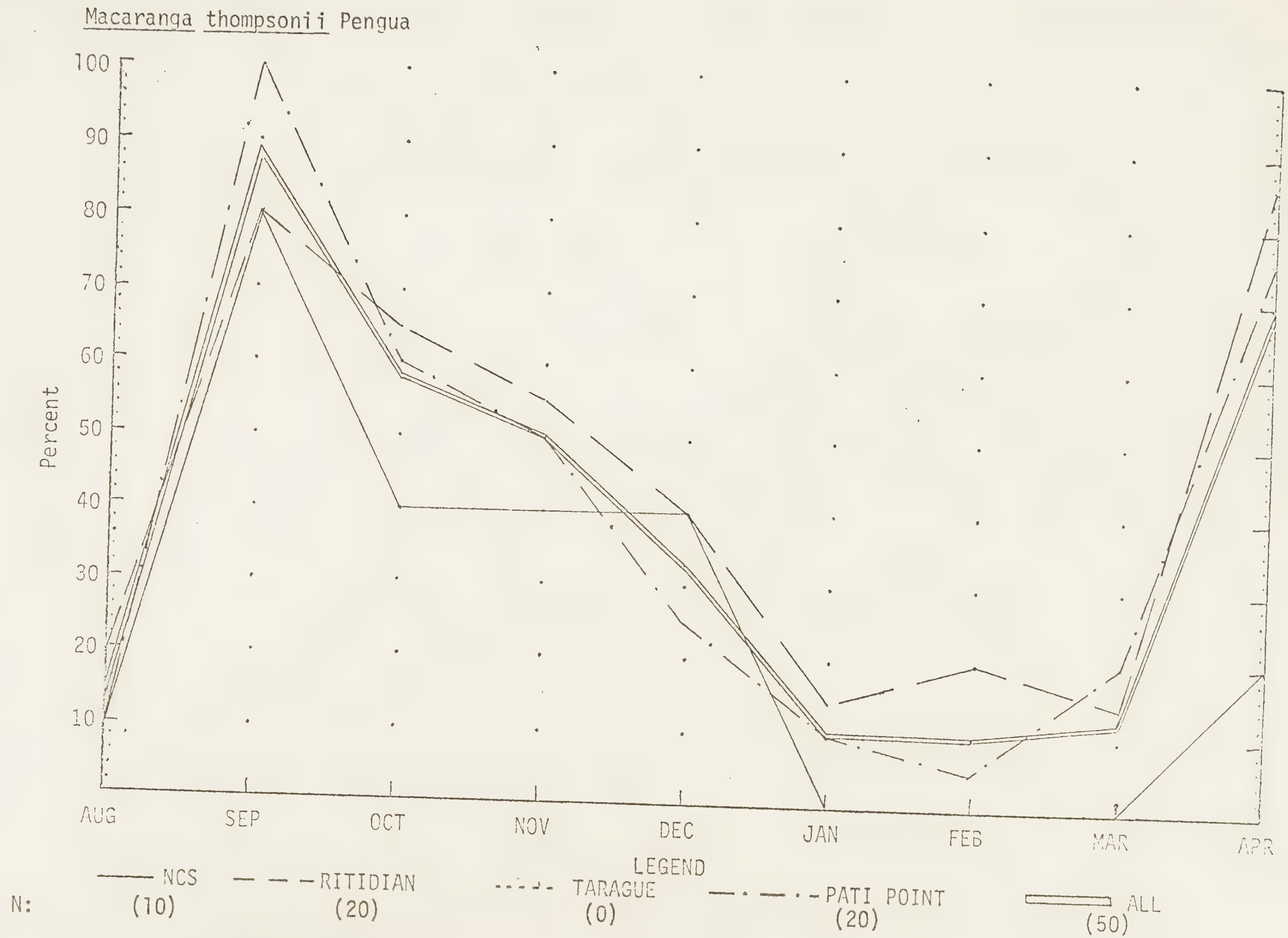

Figure 6. Percentage of Macaranga thompsoni in fruiting condition.

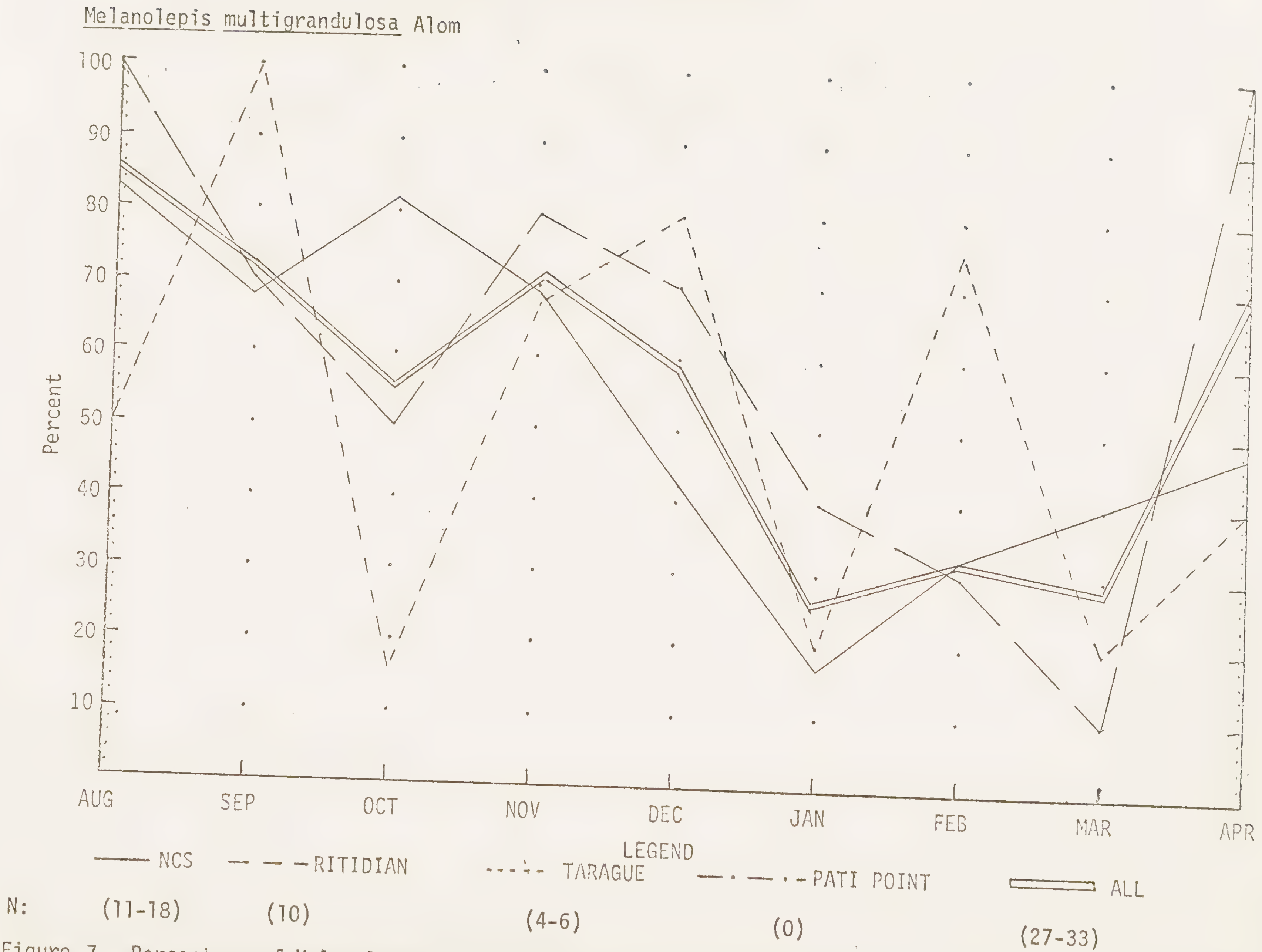

Figure 7 . Percentage of Melanolepsis multigrandulosa in fruiting condition.

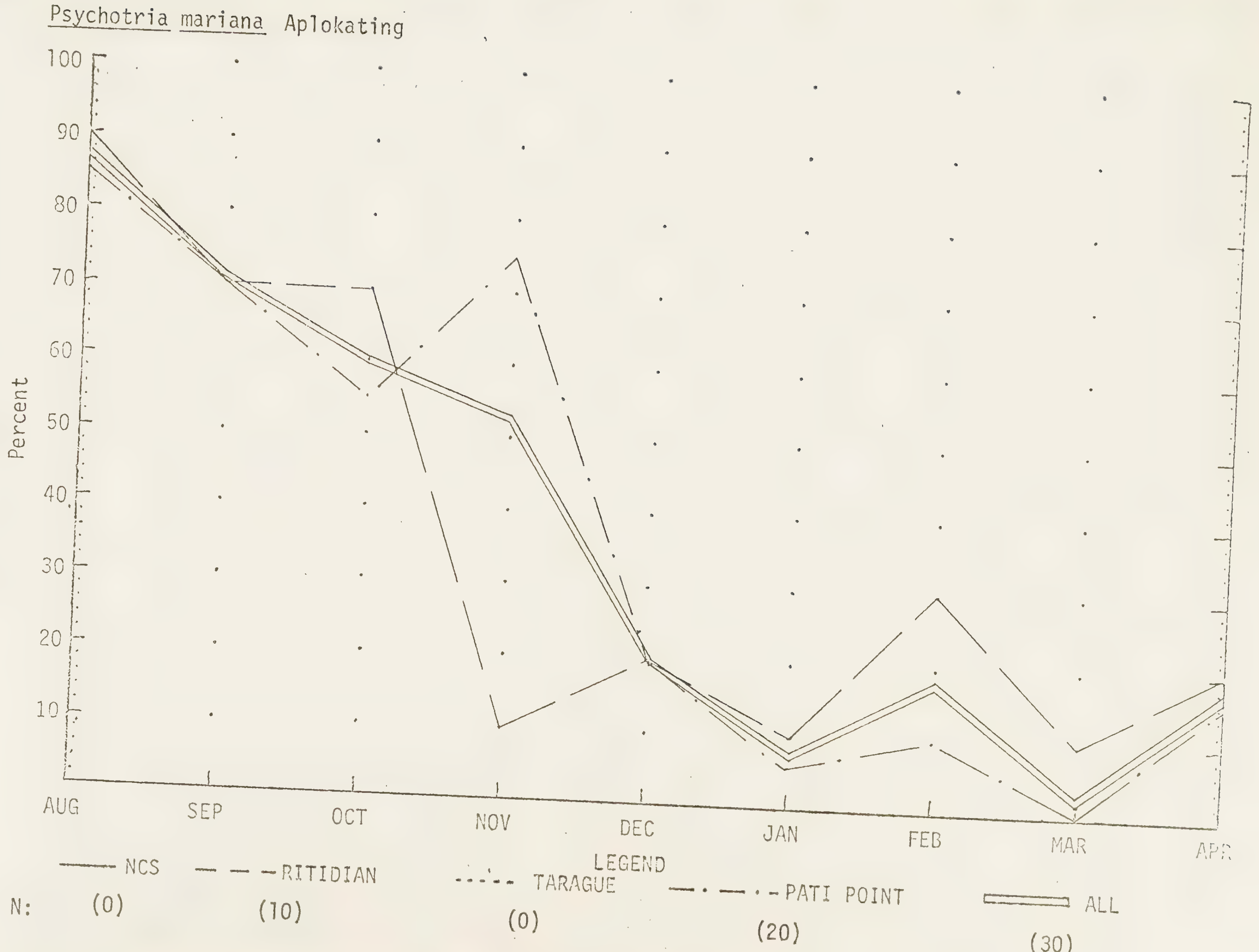

Figure 8 . Percentage of Psychotria mariana in fruiting condition.

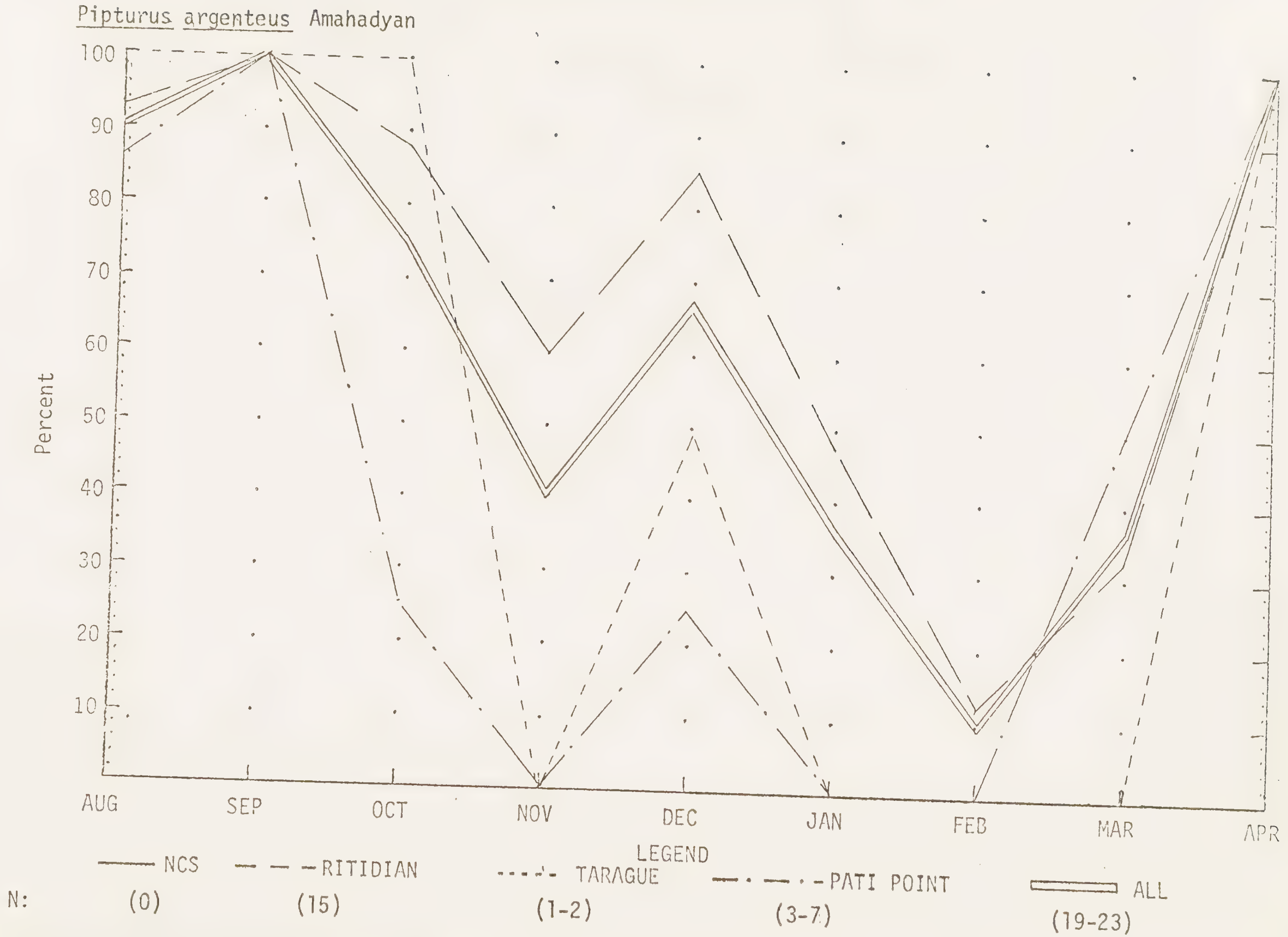

Figure 9. Percentage of Pipturus argenteus in fruiting condition.

(*Cestrum diurnum*) (Fig. 10-13). Nunu (*Ficus prolixa*) (Fig. 14) showed a gradual decline in fruiting from August to March.

Annual fruiters cease fruit production during the drier months of the year. These include: lemon de China (*Triphasia trifolia*), breadfruit (*Artocarpus mariannensis*), and a'abang (*Eugenia reinwardtiana*) (Fig. 15-17).

Intermittent fruiters characteristically ceased fruit production (all plants considered) for one month only, either January or February. Included in this category are mapunyao (*Aglaia mariannensis*), pai-pai (*Guamia mariannae*), and gapit atayake (*Wikstromea elliptica*) (Fig. 18-20). Yoga trees (*Eleocarpus sphaericus*), (Fig. 21) went into fruit production twice during the study period but this species may be more appropriately considered an annual fruiter as the fruiting in February may be an artifact of just one tree.

Trends in Abundance and Diversity. Aggregate abundance of the 20 fruiting tree and shrub species studied varied little in respect to location for the following areas: Naval Communications Station (NCS), Ritidian Point and Tarague (Fig. 22). Seasonally this index dropped to a value of about .35 for the months of October through February for these three areas, but was in the range of .40 to .50 for other months of the year. Aggregate abundance at Pati Point stands in marked contrast to the other three areas; the index steadily decreased between August and February to a low of about 0.10.

Diversity continuously decreased in all areas between September and November, reaching a 9-month low at Tarague in November, at NCS and Ritidian in December and at Pati Point in January (Fig. 23). These trends are most likely the result of annual fruiters becoming non-productive.

The product of aggregate abundance and the number of equally common fruiting species (Fig. 24) shows trends similar to that seen for aggregate abundance and diversity separately, but to a more exaggerated extent. The depressed period for this index extends from October through March. This depressed period is a result of both annual fruiters becoming non-productive and perennial fruiters becoming seasonally depressed.

Fruit Bat Abundance. The mean number of bats observed during a given month varied within the range of 0-5 bats for NCS, Ritidian and Tarague (Fig. 25). These numbers are within the range of those observed for the previous year (July 1978 - June 1979) in these areas (Wheeler 1980). Reciprocal changes at NCS and Ritidian suggest movement between these two areas, however, data are too limited to demonstrate this to an acceptable statistical significance. The much greater numbers of bats observed at Pati Point are a consequence of a colony of bats roosting in the area (Fig. 26). The number of bats that could be observed at the observation station was 90-100 bats, however, several attempts were made to climb down the cliff-side and hike through the limestone forest to a location with a better vantage point, much closer to the colony. These surveys yield a much more accurate account of the number of bats wtihin the colony. The following total counts were made:

2-27-80	180 bats	3-5-80	200 bats
2-28-80	200 bats	4-28-80	212 bats

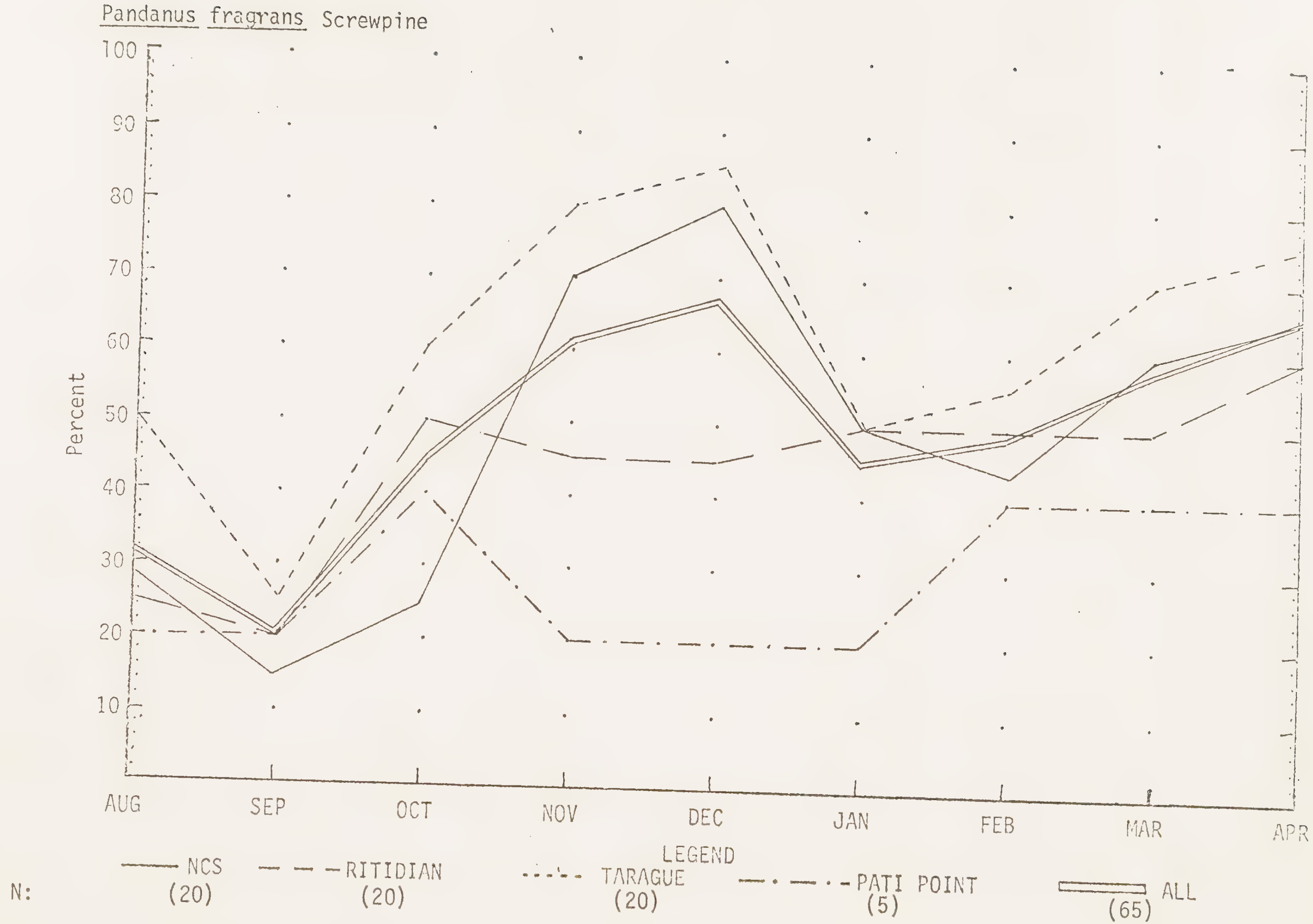

Figure 10. Percentage of Pandanus fragrans in fruiting condition.

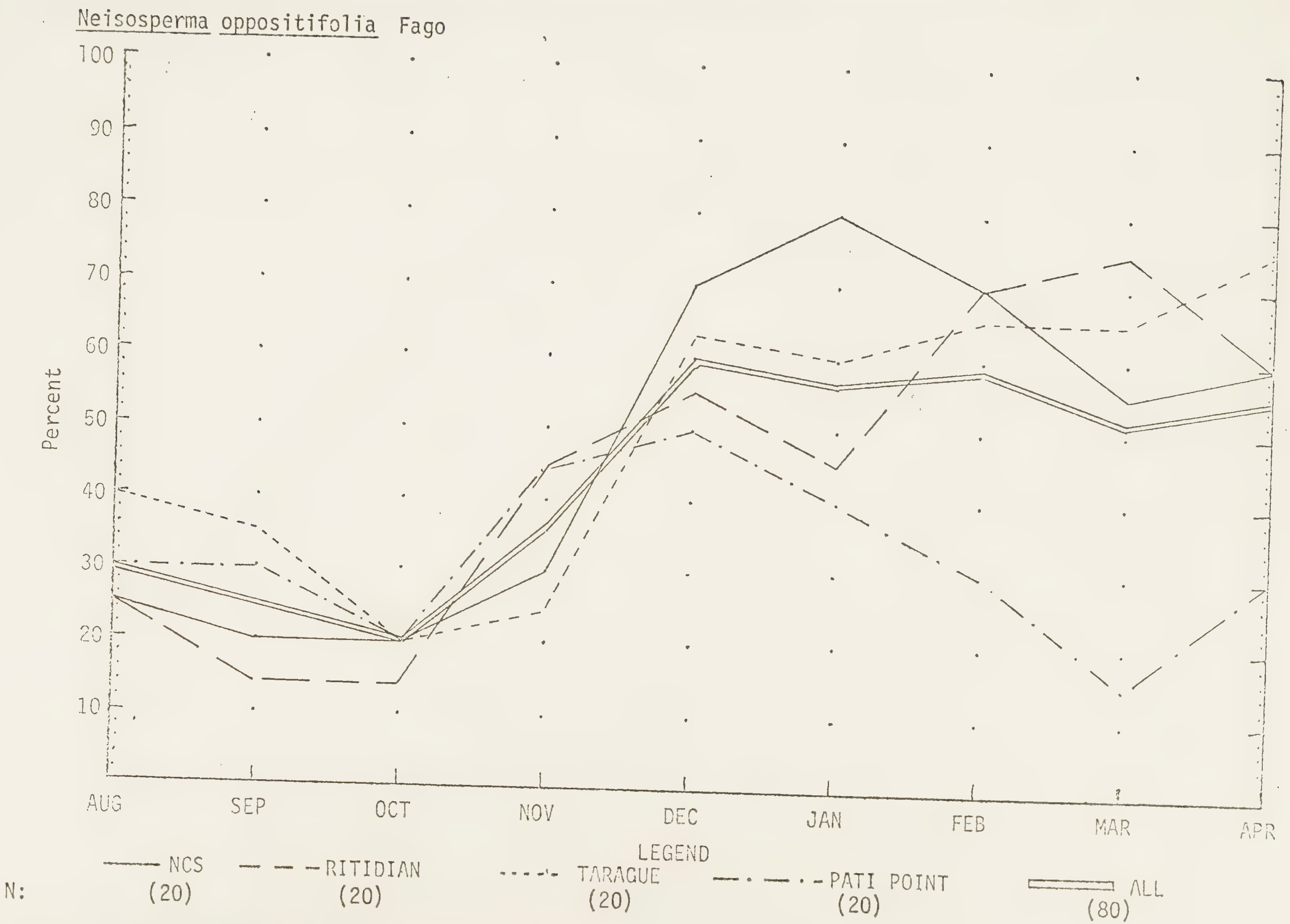

Figure 11. Percentage of *Neisosperma oppositifolia* in fruiting condition.

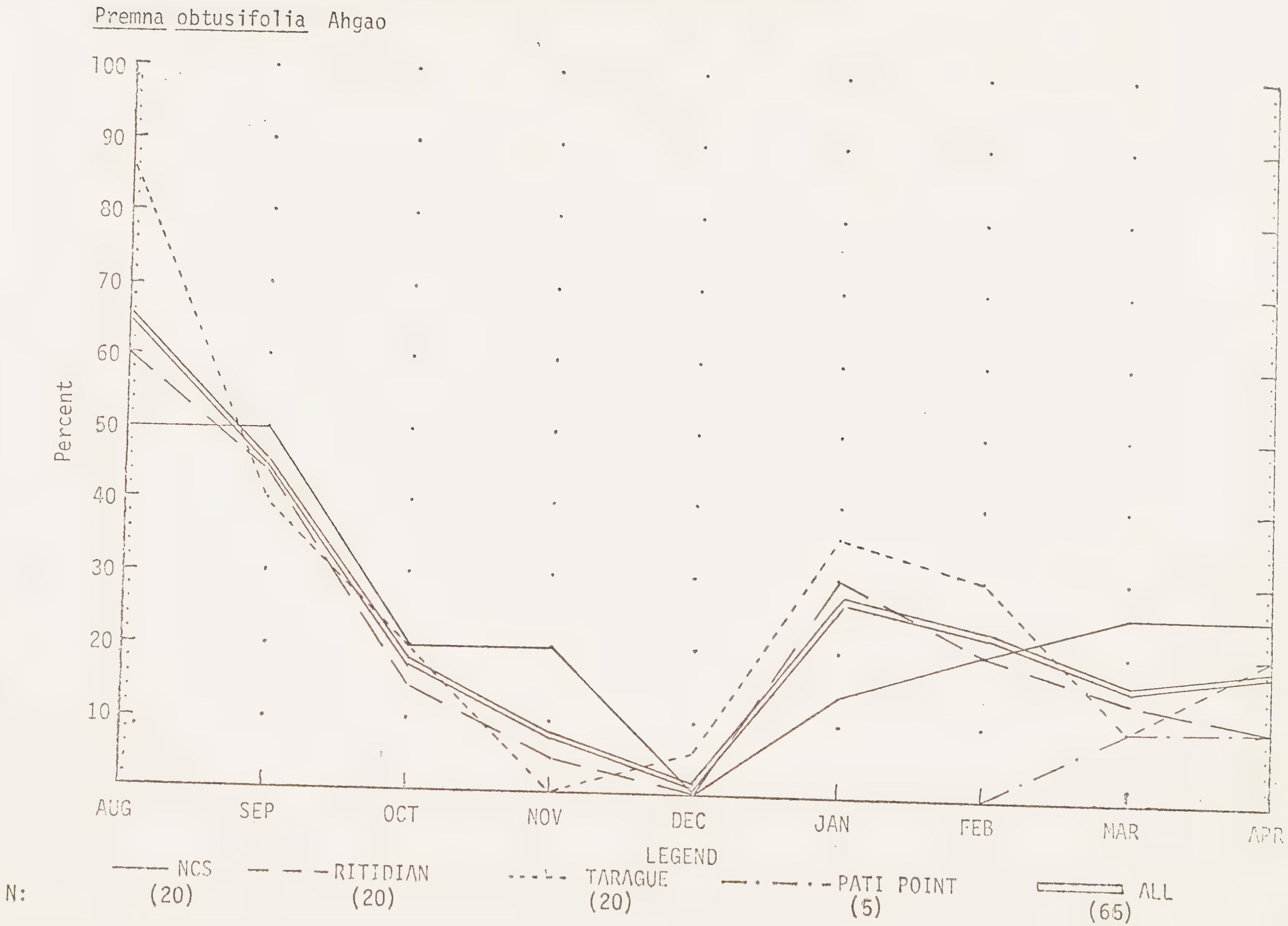

Figure 12. Percentage of *Premna obtusifolia* in fruiting condition.

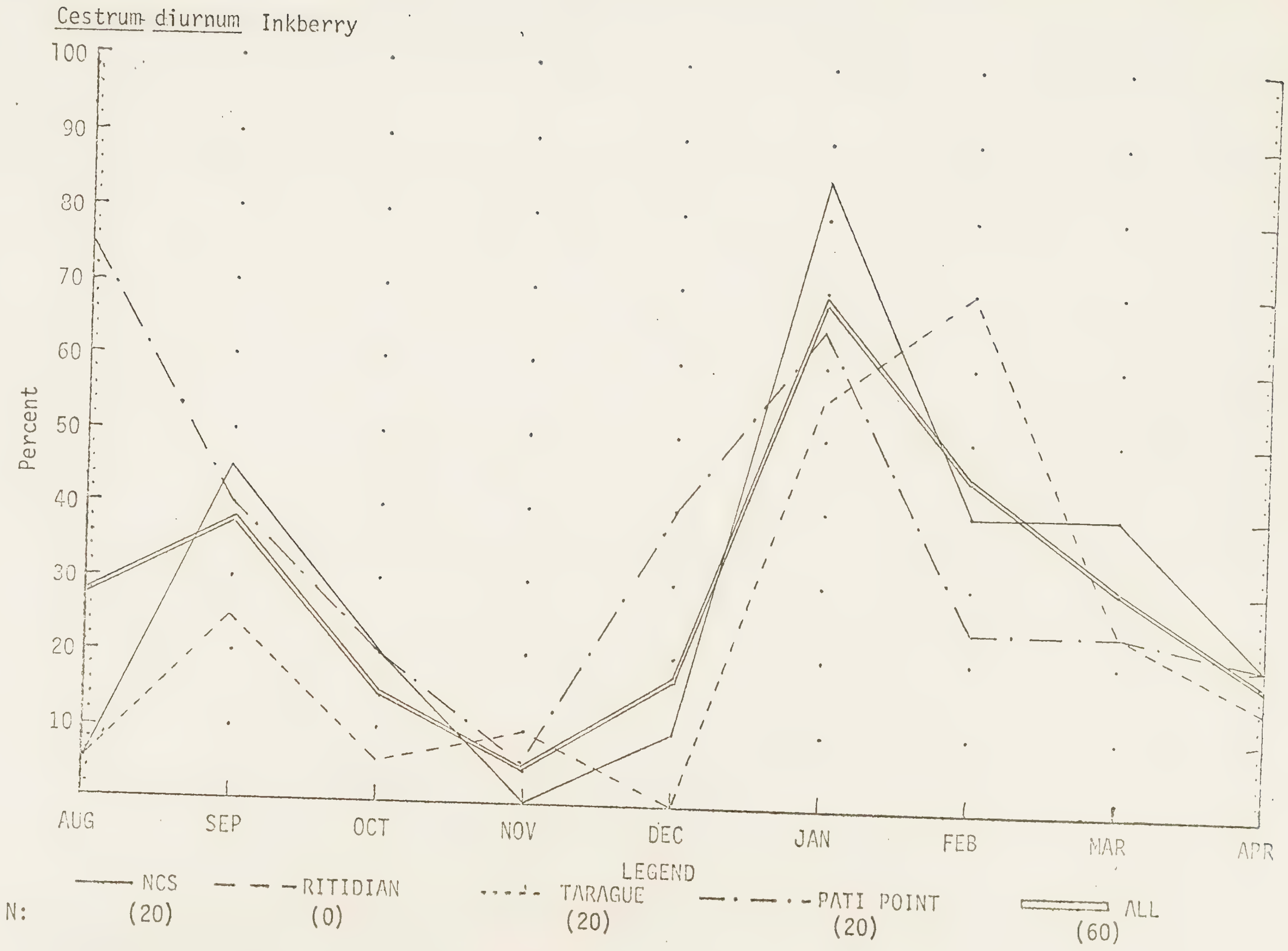

Figure 13. Percentage of Cestrum diurnum in fruiting condition.

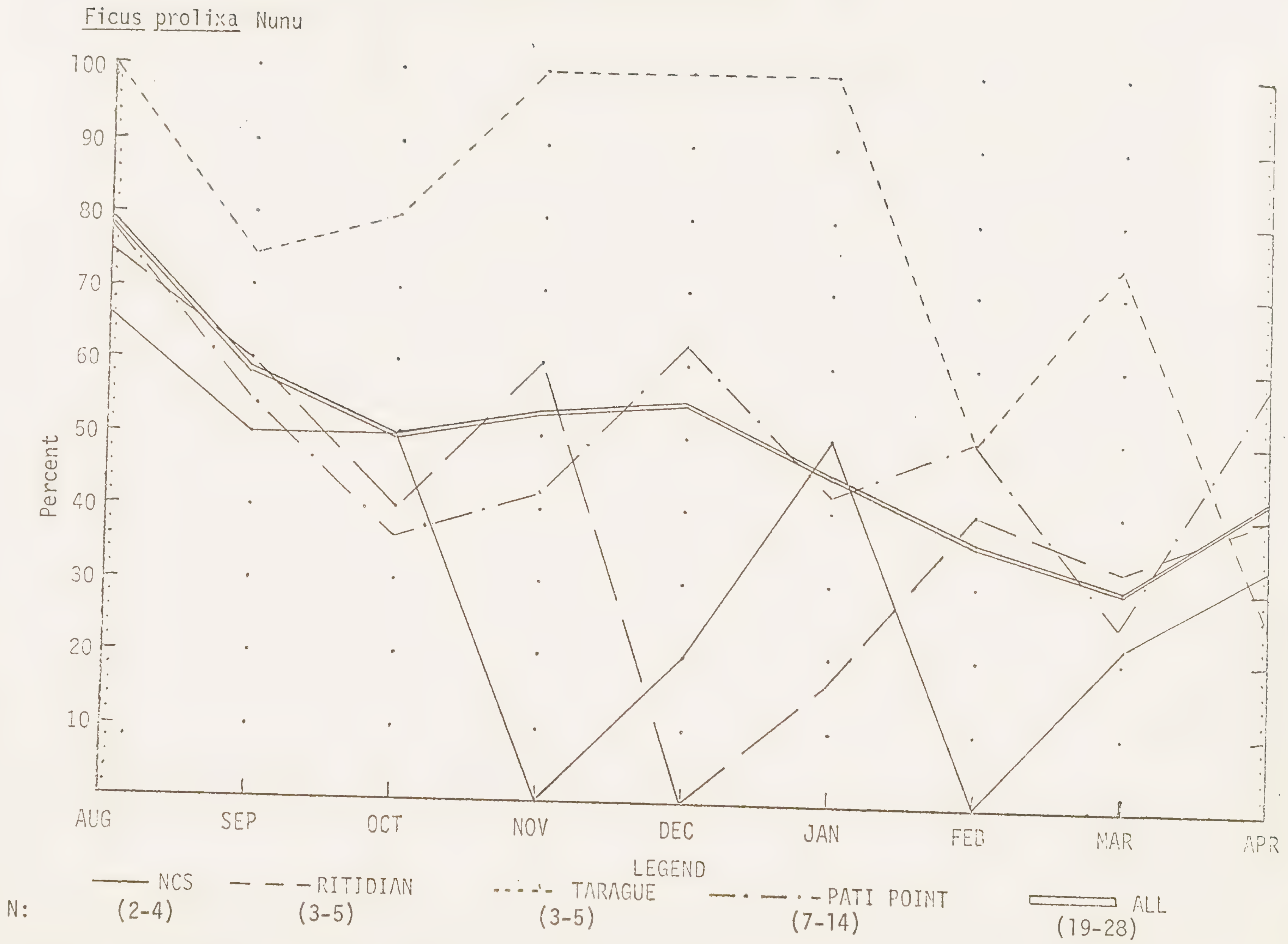

Figure 14. Percentage of *Ficus prolixa* trees in fruiting condition.

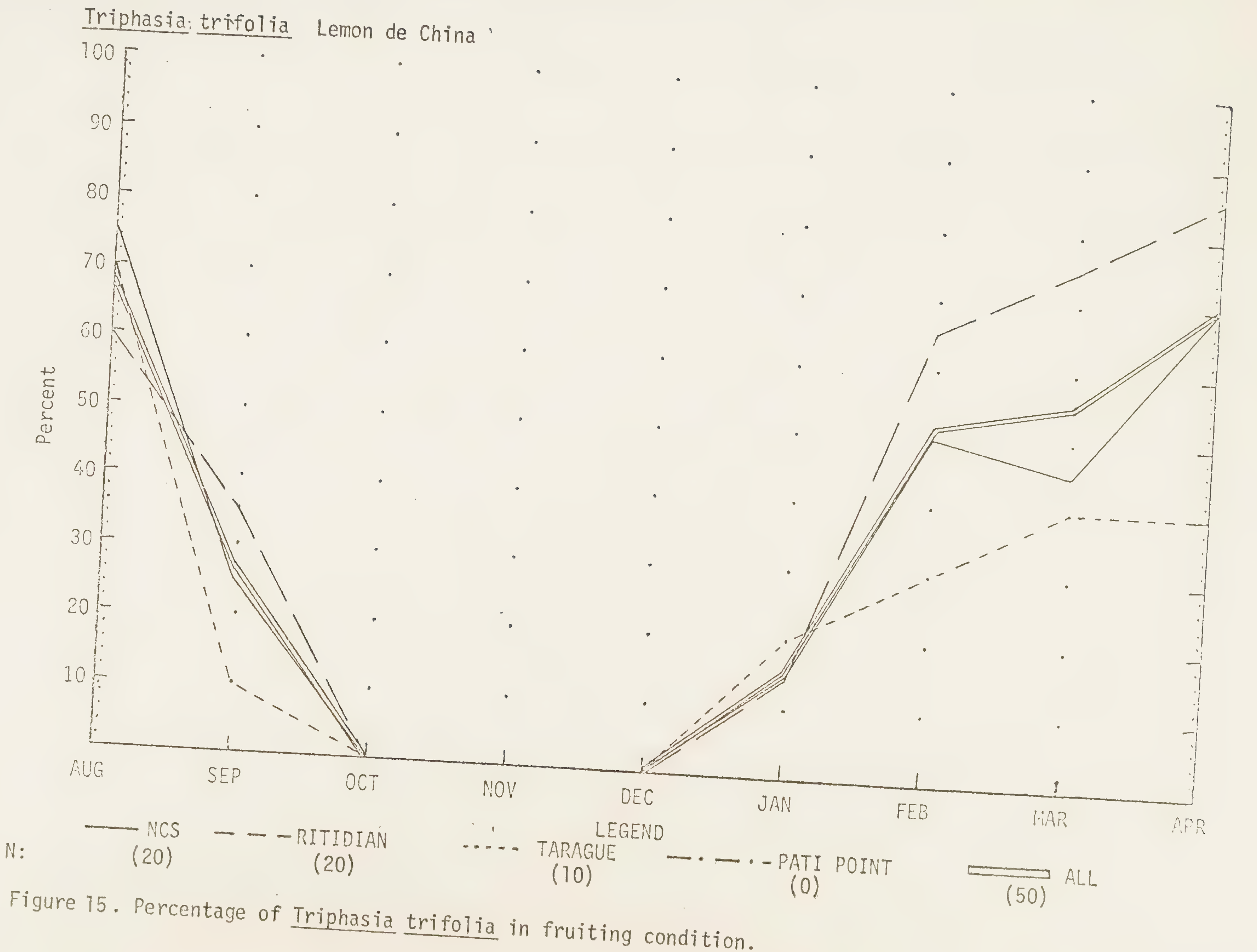

Figure 15. Percentage of *Triphasia trifolia* in fruiting condition.

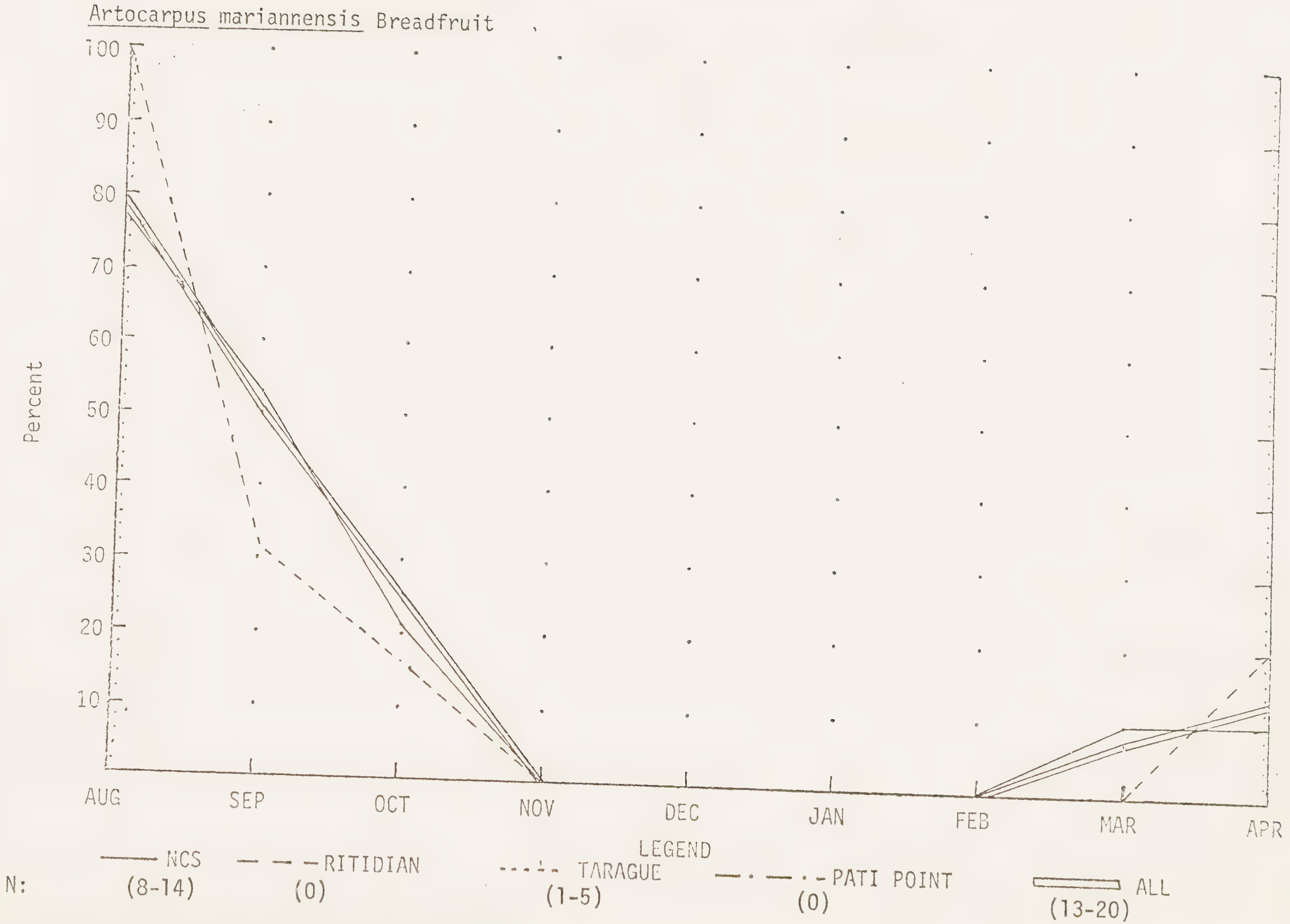
Artocarpus mariannensis Breadfruit

Figure 16. Percentage of Artocarpus mariannensis in fruiting condition.

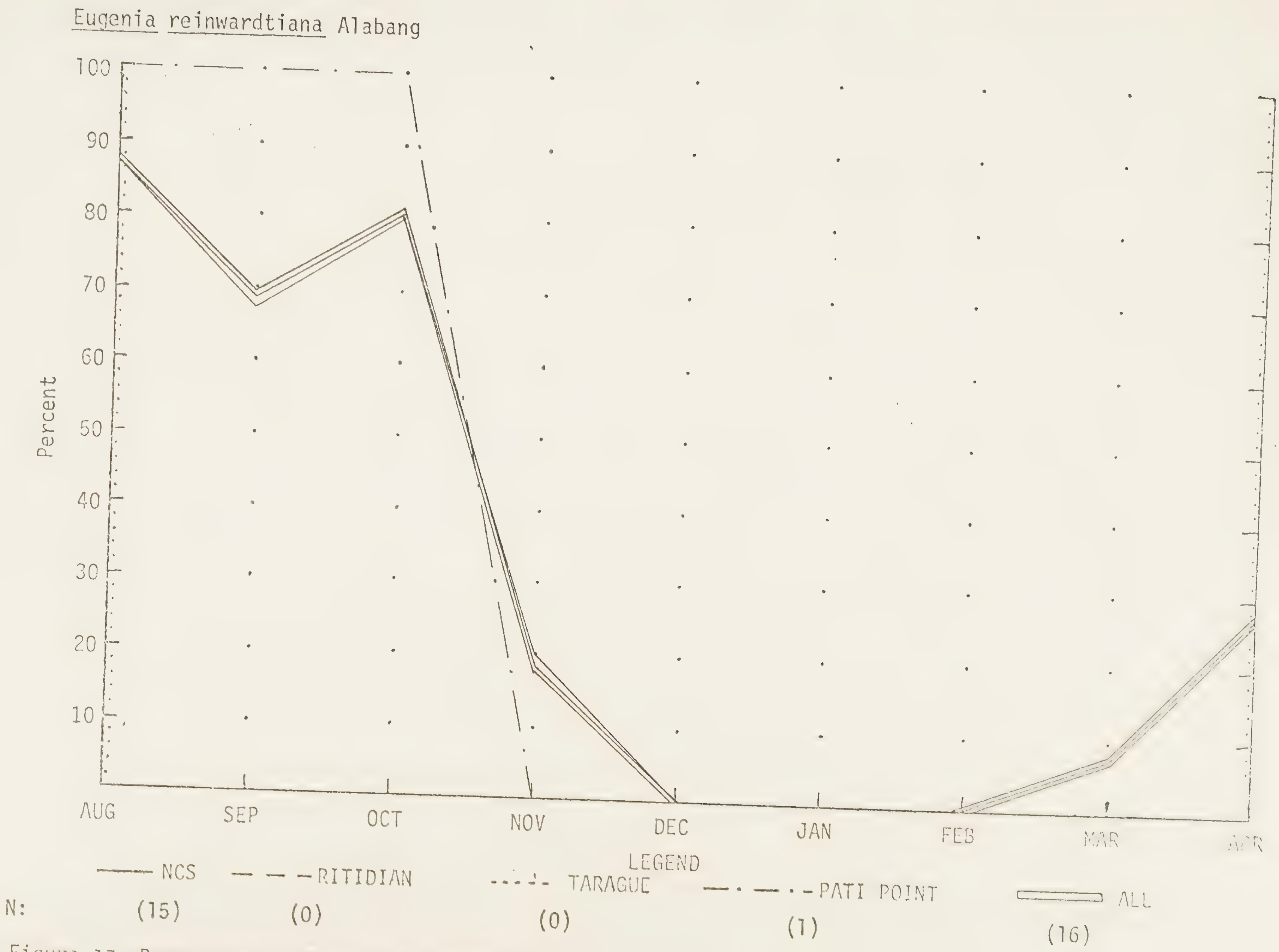

Figure 17. Percentage of Eugenia reinwardtiana in fruiting condition.

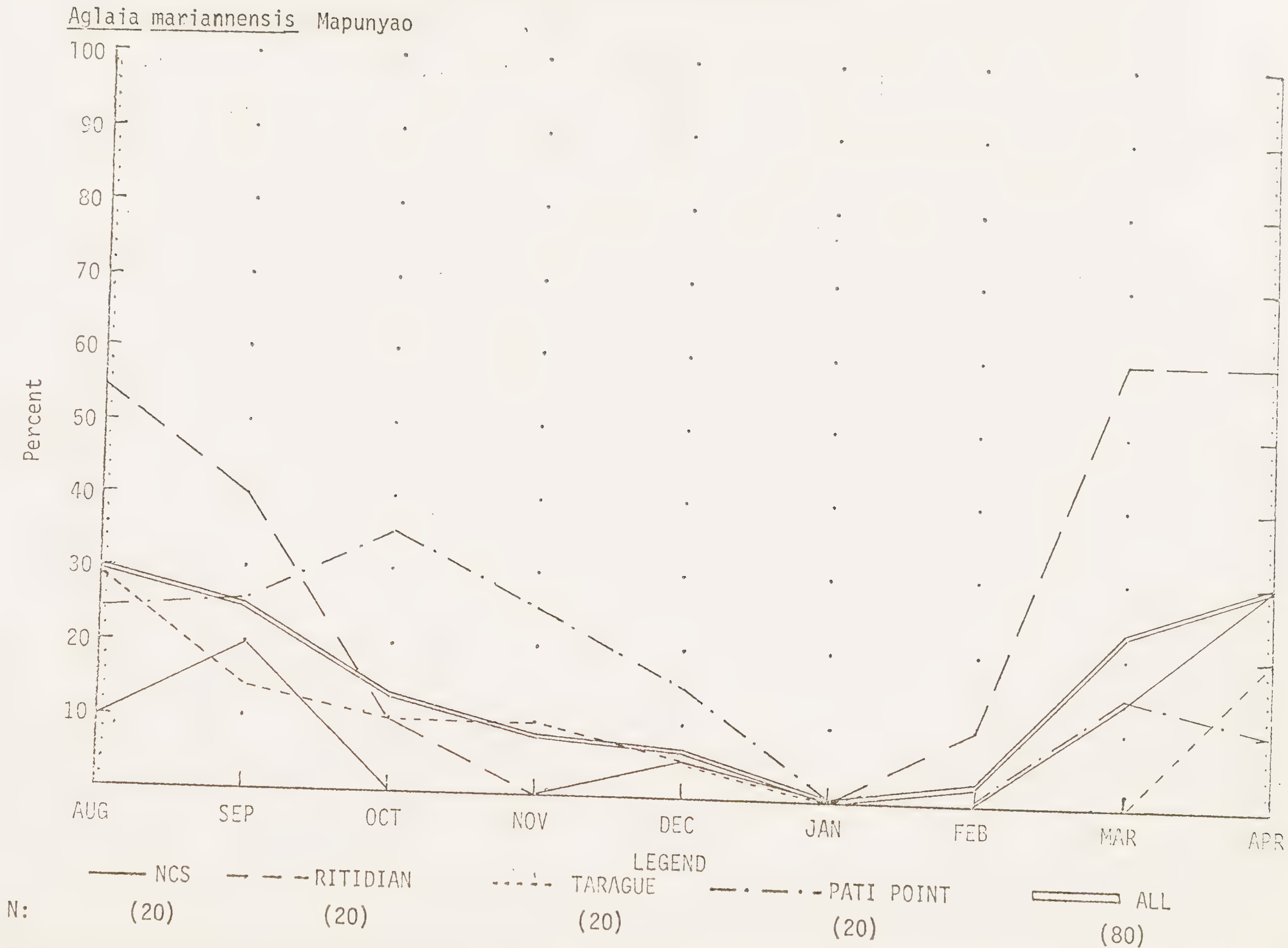

Figure 18. Percentage of *Aglaia mariannensis* in fruiting condition.

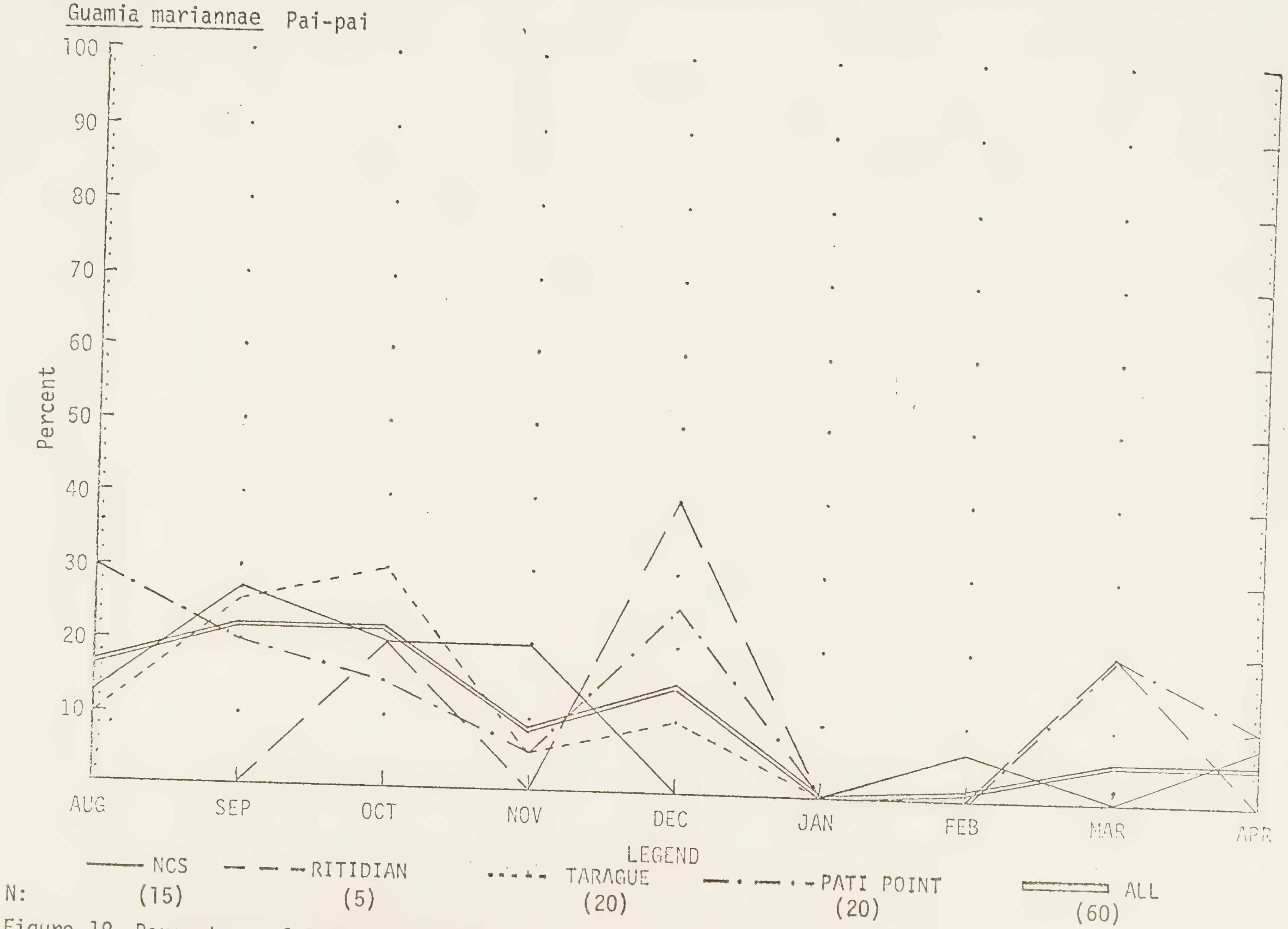
Guamia mariannae Pai-pai

Figure 19. Percentage of *Guamia mariannae* in fruiting condition.

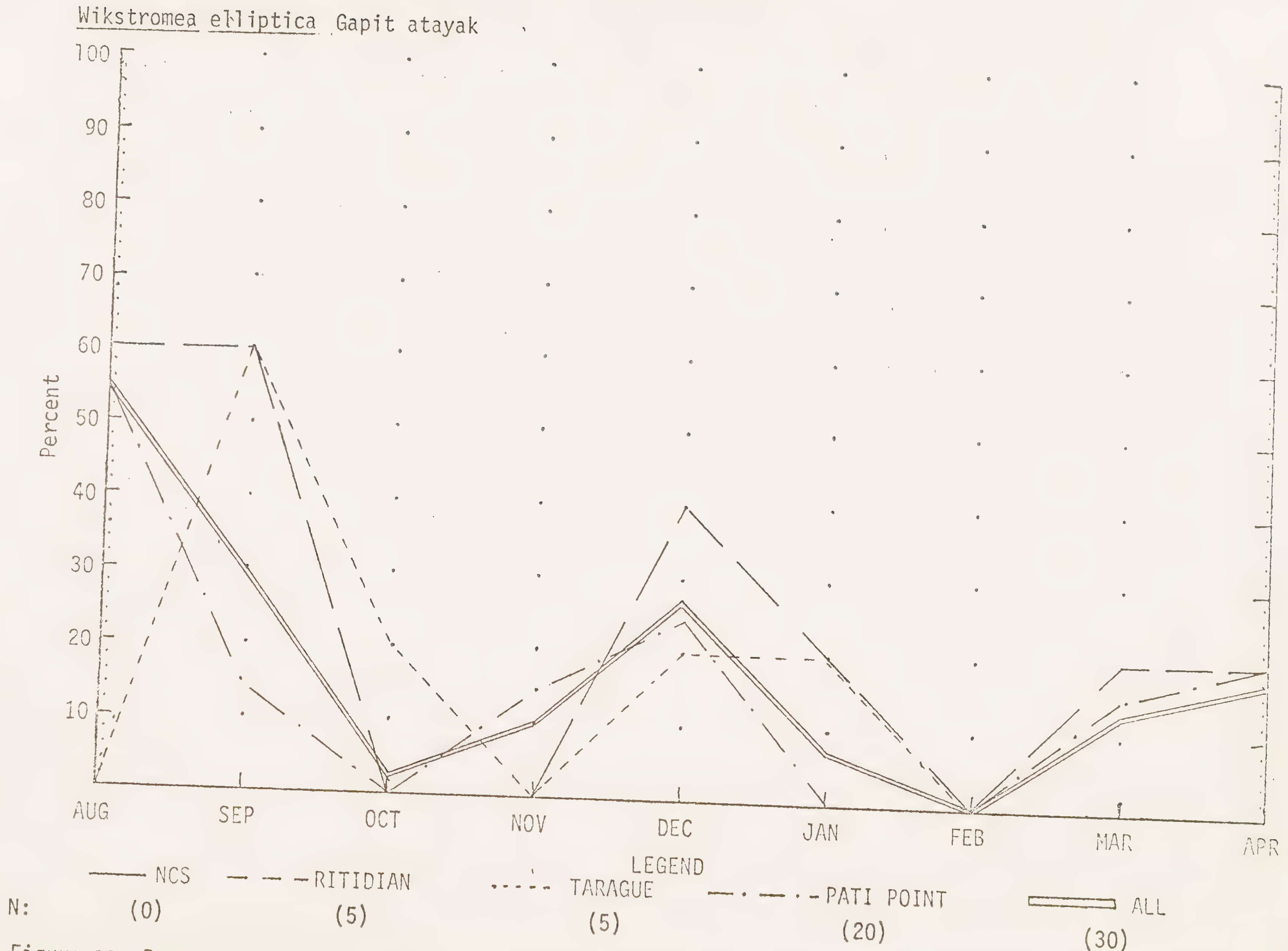

Figure 20. Percentage of Wikstromea elliptica in fruiting condition.

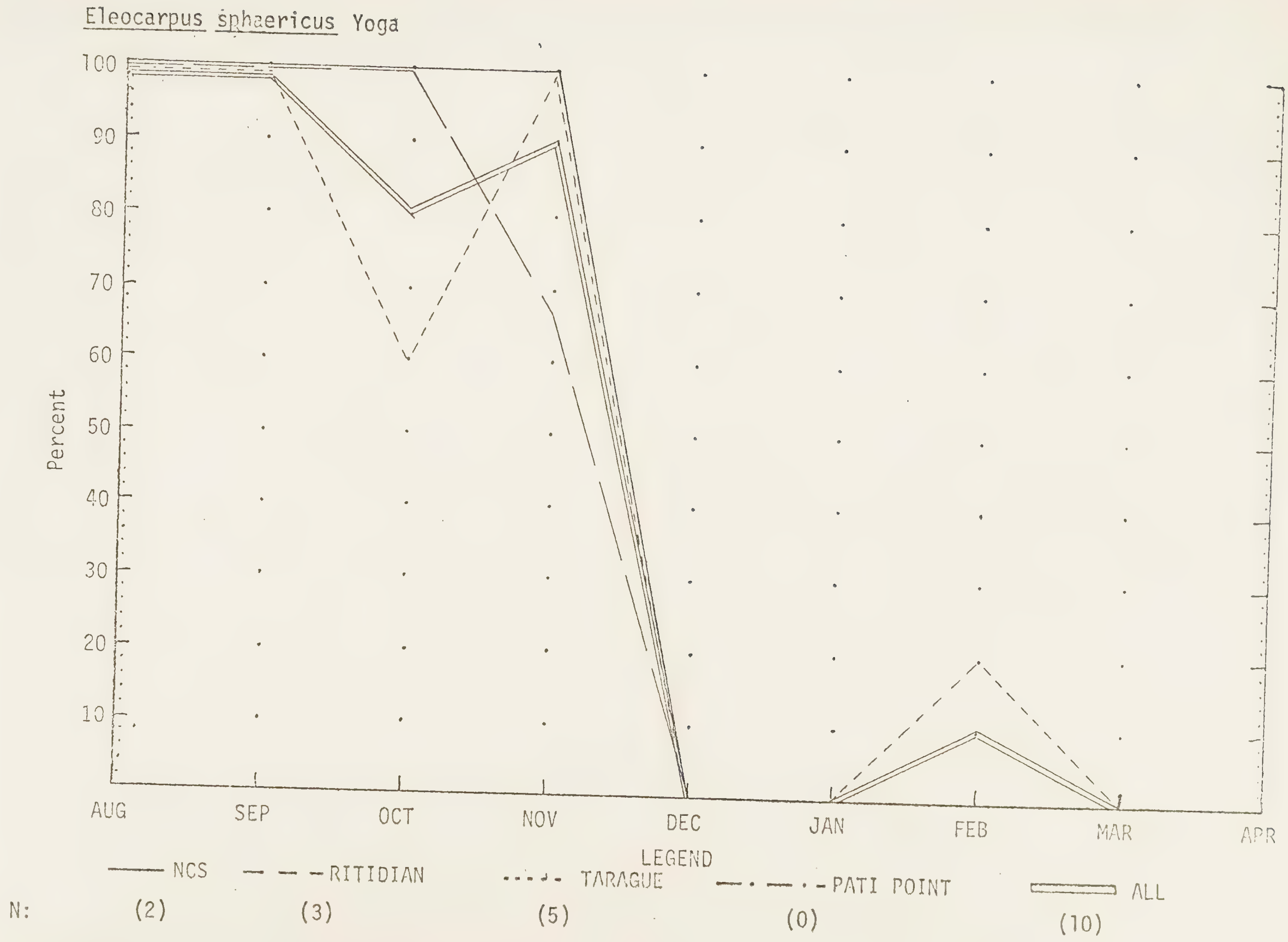

Figure 21. Percentage of Eleocarpus sphaericus in fruiting condition.

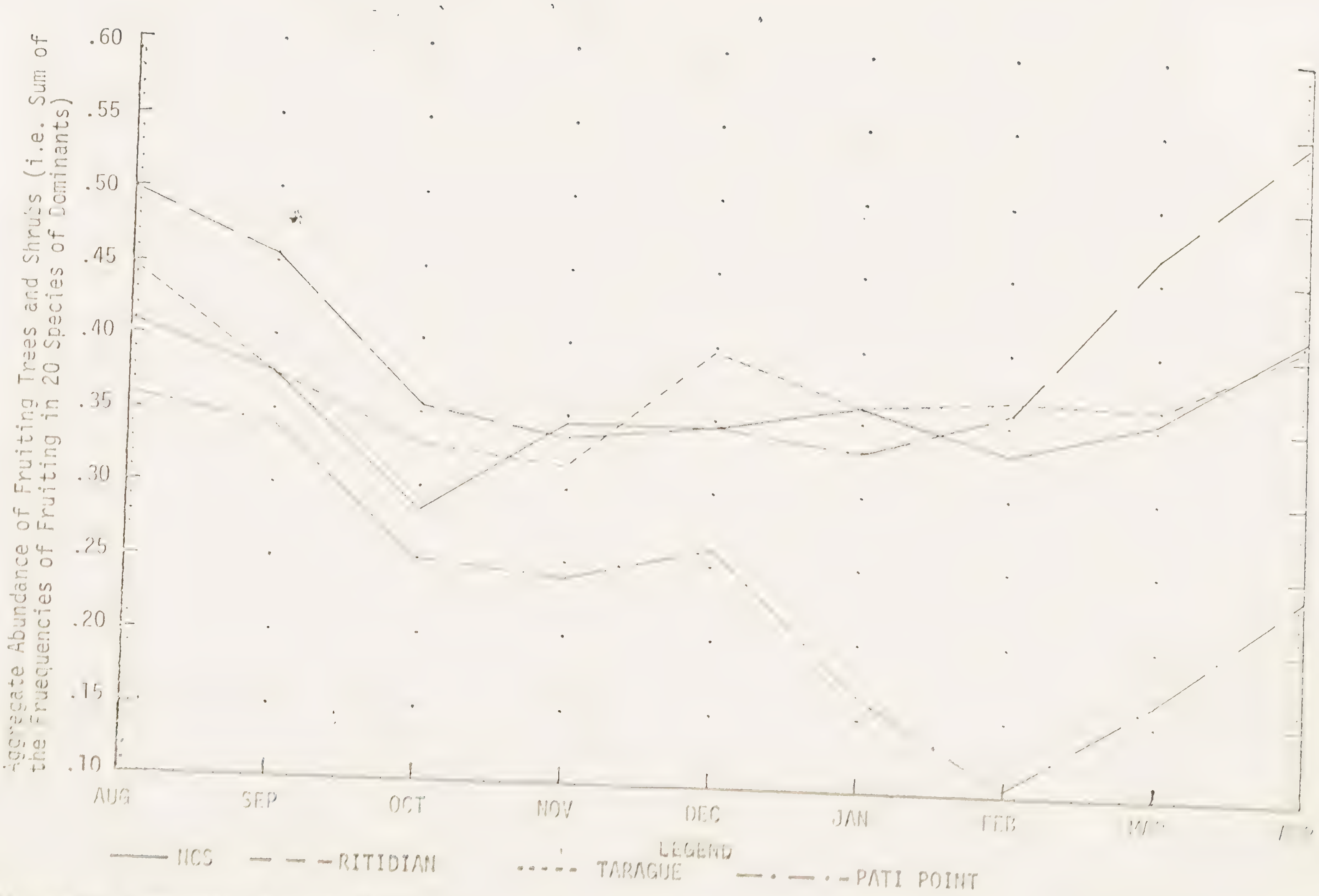

Figure 22. Comparative trends in the aggregate abundance of fruiting trees and shrubs in four areas dominated by limestone forest vegetation.

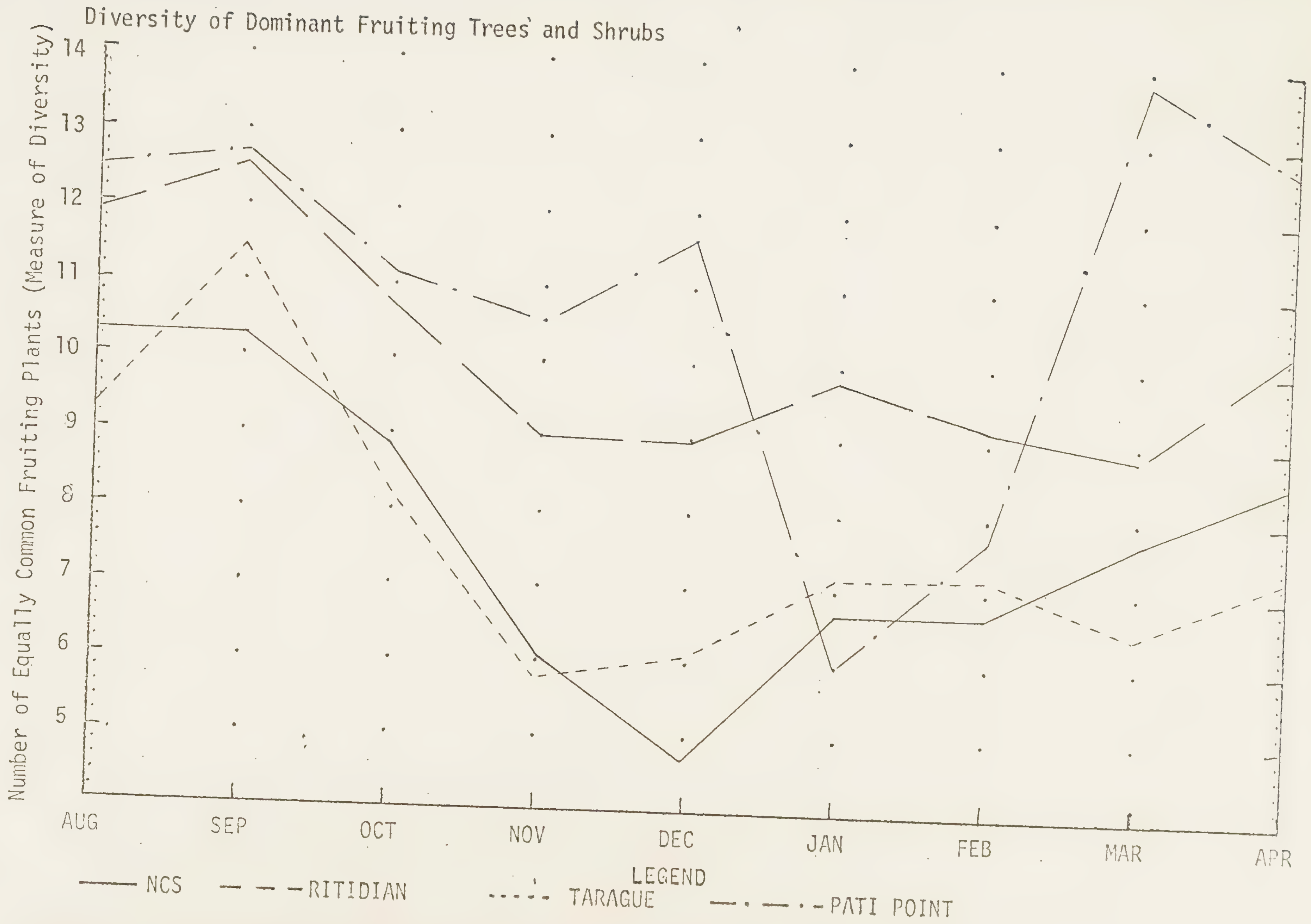

Figure 23. Comparative trends in the diversity of fruiting species in fours areas dominated by limestone forest vegetation.

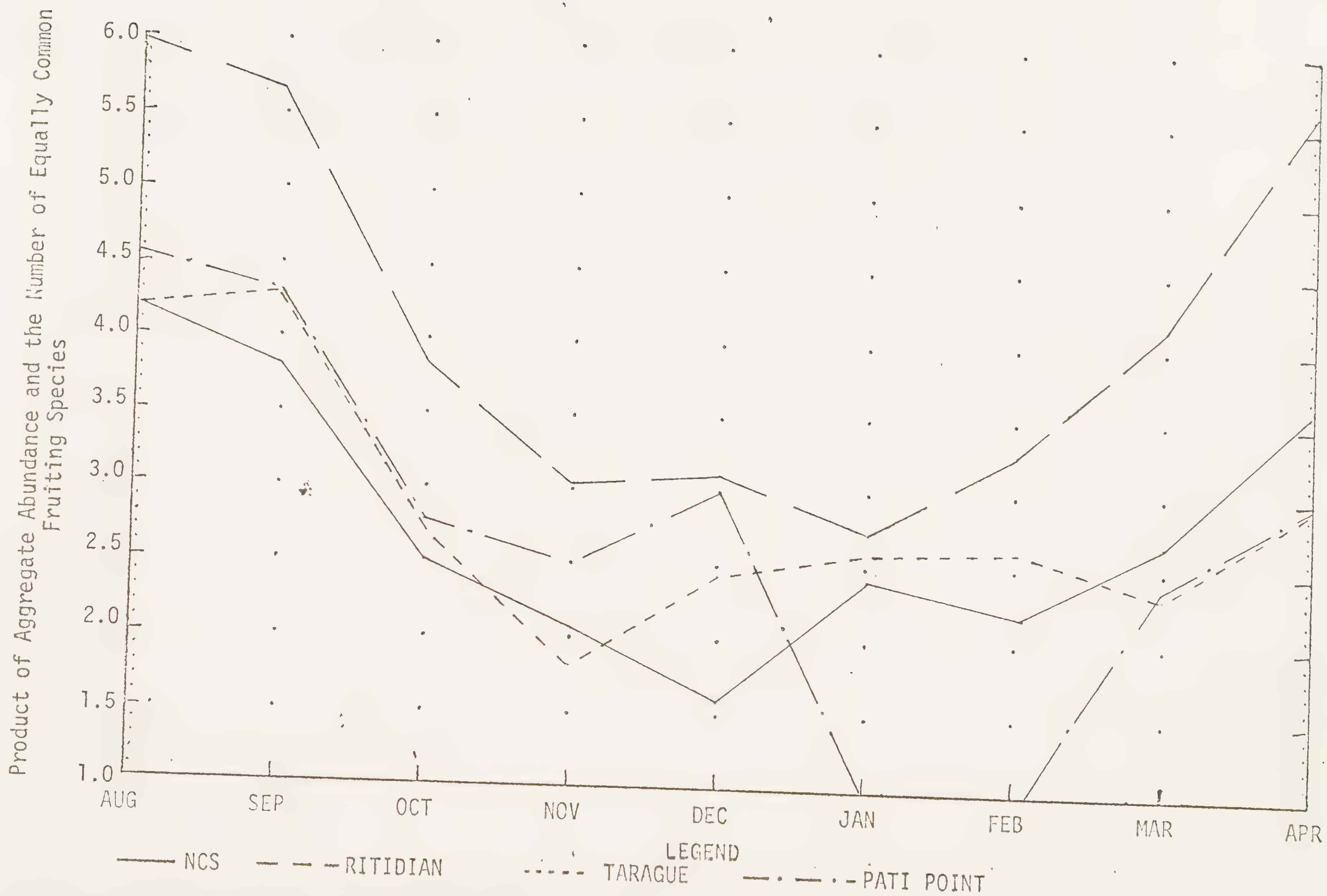

Figure 24. Comparative trends in the product of aggregate abundance and number of equally common fruiting species in four areas dominated by limestone forest vegetation.

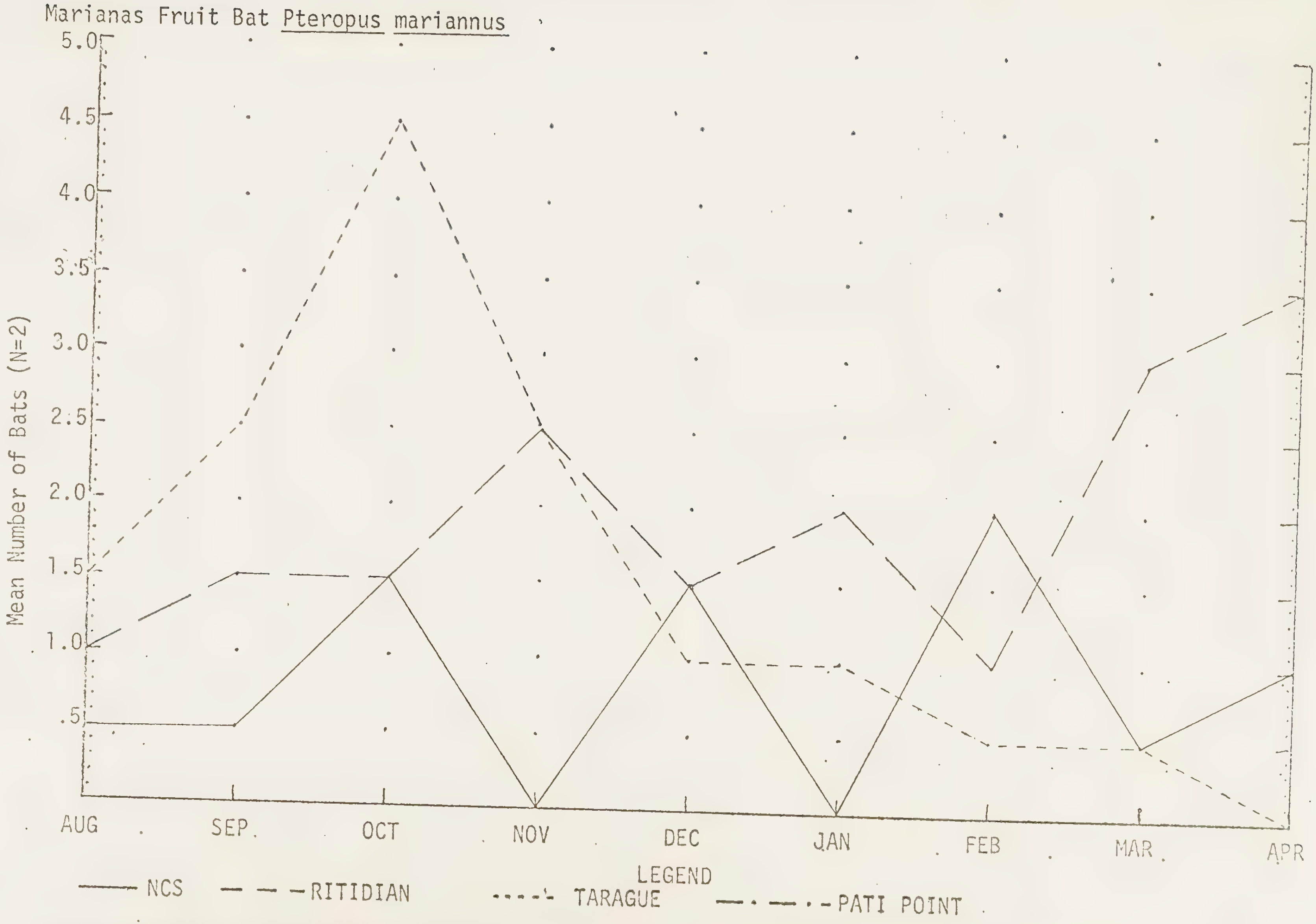

Figure 25. Mean numbers of bats observed during two one-hour station counts in each area.

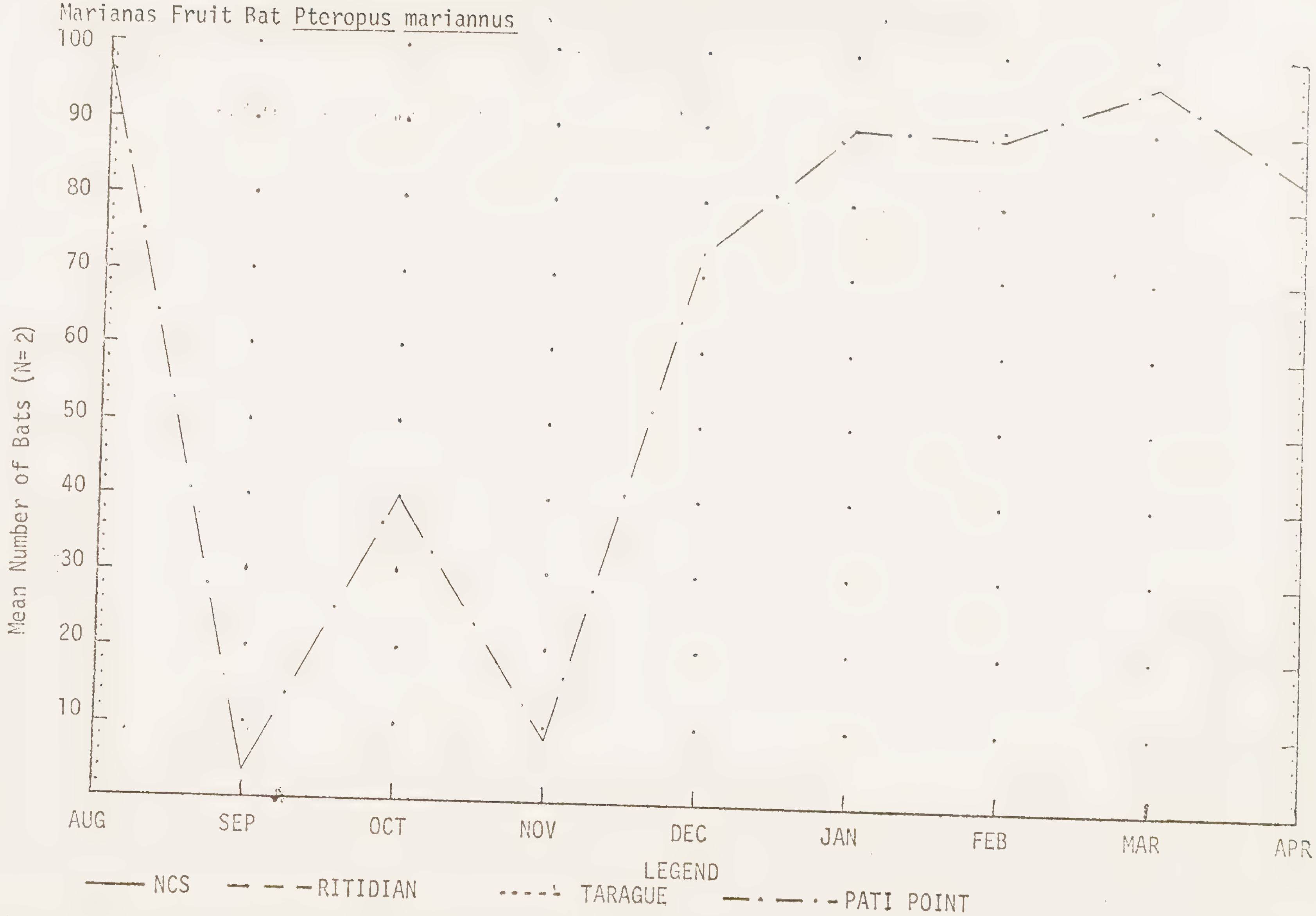

Figure 26. Mean numbers of bats observed during two one-hour station counts.

The number of bats observed from the cliffline observation station was used as an index of abundance because data were taken there throughout the period of study. The actual number of bats there may be considered as approximately twice the number observed from the station. On two occasions the bats within the colony were classified (Table 1).

Table 1. Classification of colonial roosting Marianas fruit bats.

	3-5-80 NO.	4-28-80 NO.	TOTAL NO.	Percent of CLASSED BATS
Adult Males	15	11	26	25.7
Adult Females w/Young	7	7	14	13.9
Young of the Year	7	7	14	13.9
Adult Females w/o Young	24	17	41	40.6
Juvenile Males	2	0	2	2.0
Juvenile Females	0	1	1	1.0
Unsexed Juvenile	2	1	3	3.0
Unclassed Bats	143	168	311	

Approximately one out of three adult females had young. Those classified as juveniles probably represent recently weaned bats, whereas the juvenile class should contain bats in their second year of life. Some second year bats may have been classified as adults as it is difficult to distinguish these older juveniles from adults. Those classified as juveniles were unquestionably so.

Relation Between Fruit Bats and Fruiting Plants. Product-moment correlation test (Sokal and Rohlf 1969) were performed between the following: fruit bat abundance vs. aggregate fruiting plant abundance index; fruit bat abundance vs. equally common fruiting plants (diversity); and fruit bat abundance vs. the product of aggregate abundance and diversity of fruiting plants. These test were performed separately for each area and for all areas combined (Table 2).

Table 2. Product-moment correlate coefficients of tests between fruit bat abundance and parameters of abundance and diversity of fruiting plants.

BATS VS.	AGGREGATE FRUITING PLANT ABUNDANCE (AA)	EQUALLY COMMON FRUITING PLANTS (E)	PRODUCT AA x E
NCS	-.40	-.16	-.28
Ritidian	.36	-.36	.06
Tarague	-.50	.34	.10
Pati Point	-.39	-.15	-.32
Overall "r"	-.67*	.34	-.26

*Significant correlation at P<.01.

The only statistically significant correlation found was that between fruit bat adundance and the overall value for aggregate fruiting plant abundance. Apparently, where fruit bats become abundant, aggregate fruiting plant abundance goes down. This could be a result of fruit bats efficiently utilizing a number of the fruiting plants monitored for this study. The data also suggest that fruit bats are not obligately dependent on a great diversity of fruits being available. It is interesting to note that the abundance and diversity of fruiting plants showed marked declines at Pati Point during January and February (Fig. 22 & 23). This in contrast to the other areas. Pati Point's bat population was of several magnitudes higher than the ogher areas. One plant that exhibited an uncharacteristic decline in fruit abundance at Pati Point was fayo (Neisosperma oppositifolia) (Fig. 11), and it is possible that bats were feeding heavily on this.

Avian Densities and Trends in Abundance. In terms of avian densities in the limestone forest (Table 3), the Micronesian starling (Aplonis opacus) is by far the most numerous bird, and was found abundantly at all four areas. Second in abundance was the Philippine turtle dove (Streptopelia bitorquata), followed by the cardinal honey-eater (Myzomela cardinalis) and the black drongo (Dicrurus macrocercus), all three of these species being found at all locations. Notably absent from NCS and rare in other areas were the rufous-fronted fantail (Rhipidura rufifrons) and the Micronesian broadbill (Myiagra freyineti). Taking detection distances into consideration, the Marianas crow (Corvus kubaryi) appears to be about as scarce as the Marianas fruit dove (Ptilinopus roseicapillus), and the white-throated ground dove (Gallicolumba xanthonura) is even more scarce in limestone forest habitat. Trends in abundance are shown in Figures 27-38. All species were observed in at least one of the study areas for all months of the study with the exception of the Guam rail (Rallus owstoni) and the bridled white-eye (Zosterops conspicillata), both of which were not observed one month during the study period. Data on these two species were too few to estimate density.

Relationships Between Fruit Bats and Birds. Data collected in fiscal year 1979 (Wheeler 1980) indicate some significant associations between fruit bats and some fruit eating birds (Table 4). The relatively strong association between fruit bats and starlings is undoubtedly a result of the widespread abundance of the latter. Fruit doves and fruit bats are probably both dependent on mature forest, leading to a positive association between these two species. The Philippine turtle dove is ubiquitous on Guam and is observed utilizing limestone forest throughout the year. This dove is apparently more of a generalist than the native doves and is found in most of the habitats on Guam. There may be stratographic separation of the fruit eating fauna within the limestone forest, leading to partitioning of the food resource, however, there are insufficient data on height ranges utilized by the avifauna within the forest. Observations of agonistic behavior between fruit bats and fruit-eating birds on Guam have not been made, in spite of many years of field effort by several biologists. Only the black drongo is known to harass fruit bats (Perez 1972, Bruner and Pratt 1979), but there was no significant negative association between these two species (Table 4), suggesting the black drongos do not locally exclude fruit bats. Generally, fruit bats utilize some "...large fruits, which are too heavy for birds to transport and too pendulous for many other mammals to reach." (Constantine, In: Wimsatt 1970).

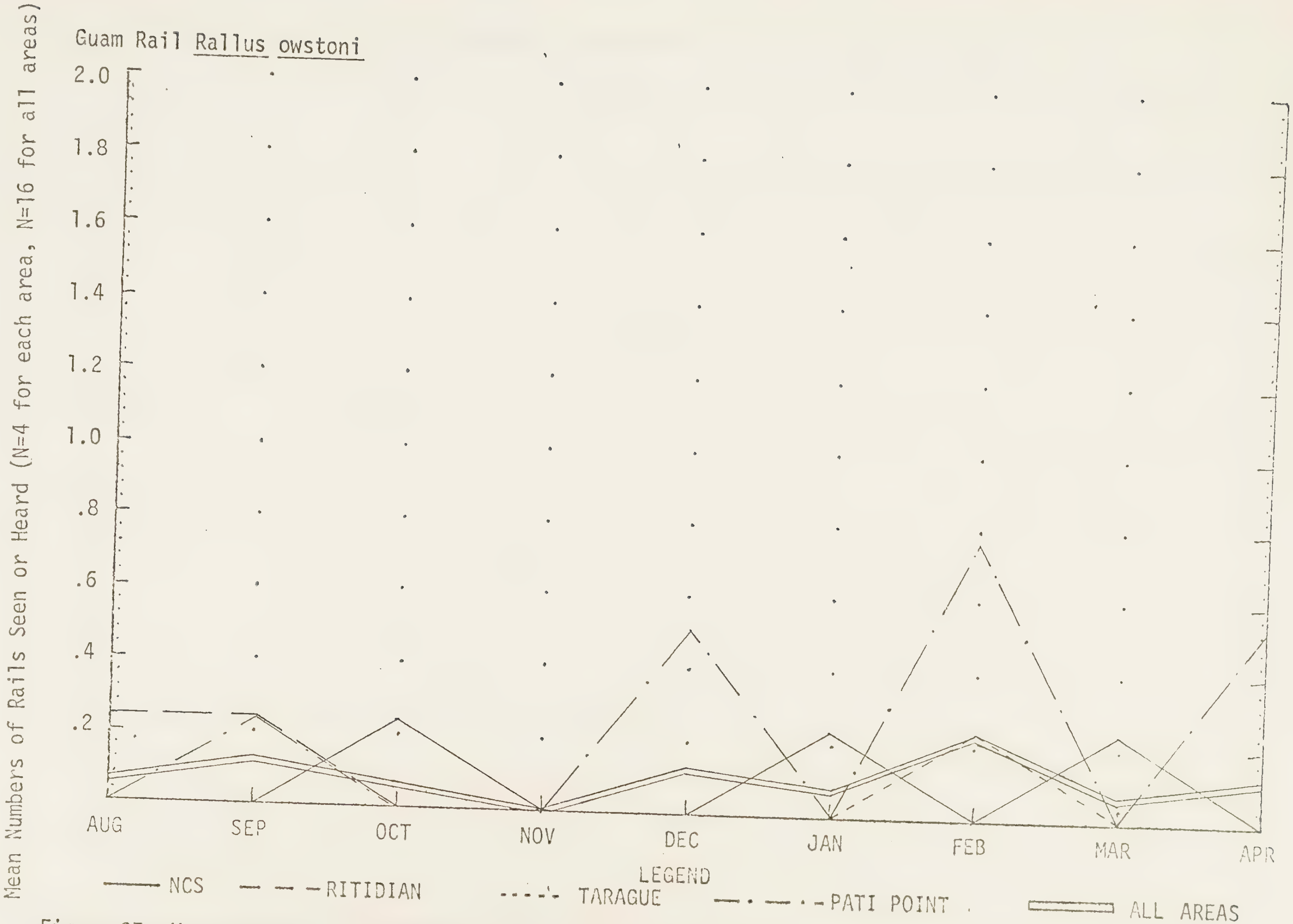

Figure 27. Mean numbers of rails observed or heard during four 15-minute station counts.

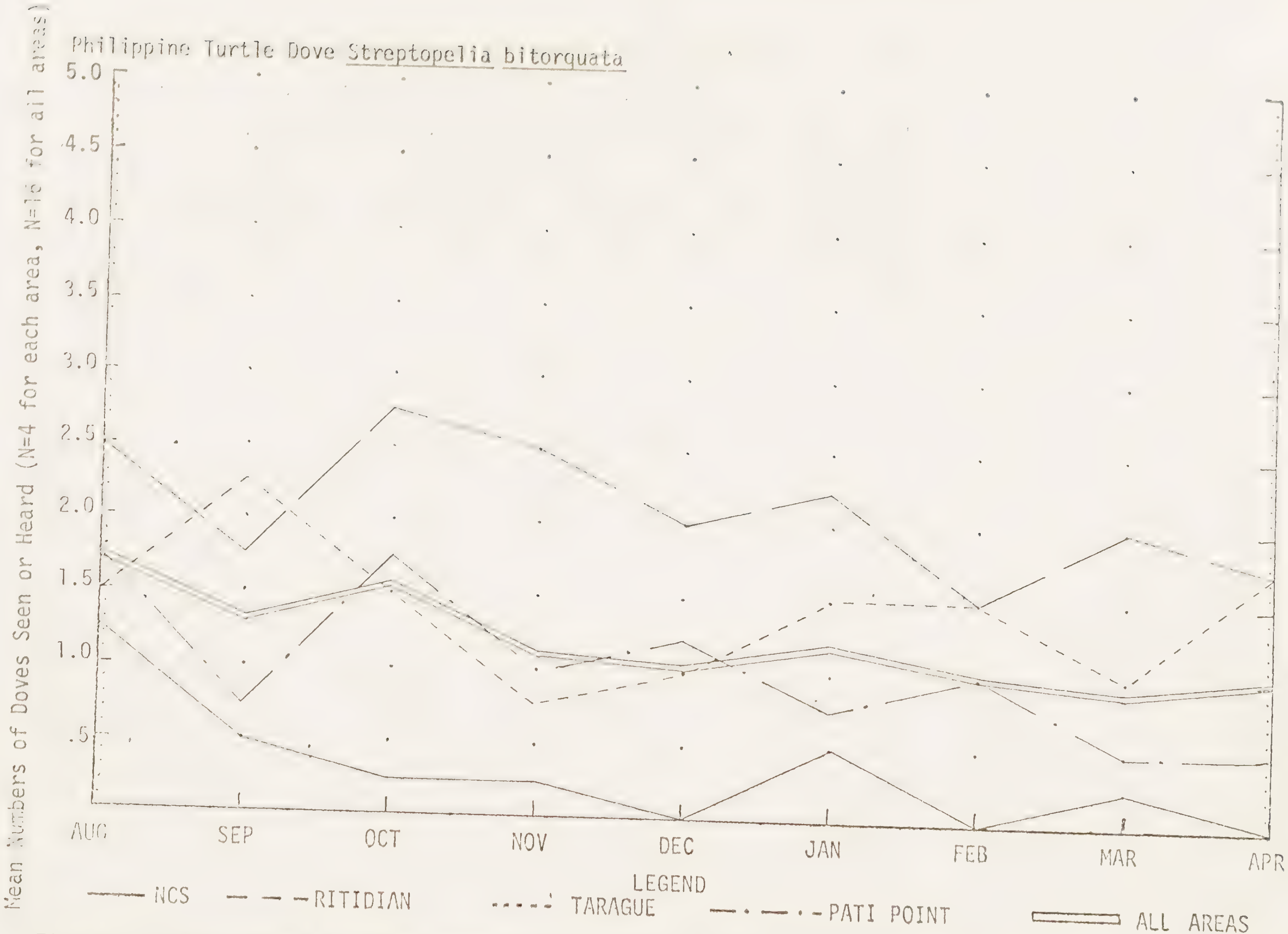

Figure 28. Mean numbers of doves observed or heard during four 15-minute station counts.

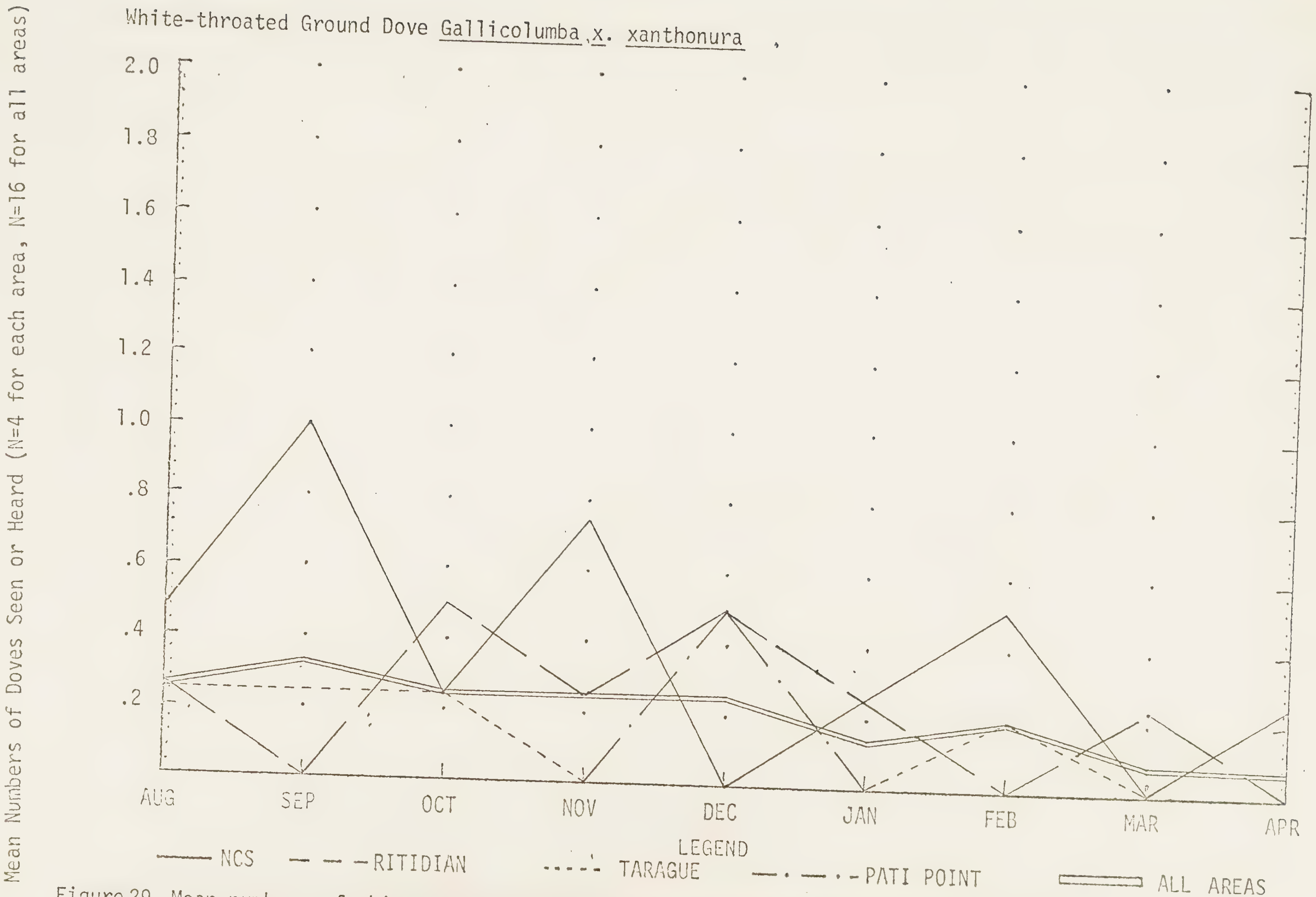

Figure 29. Mean numbers of white-throated ground doves observed or heard during four 15-minute station counts.

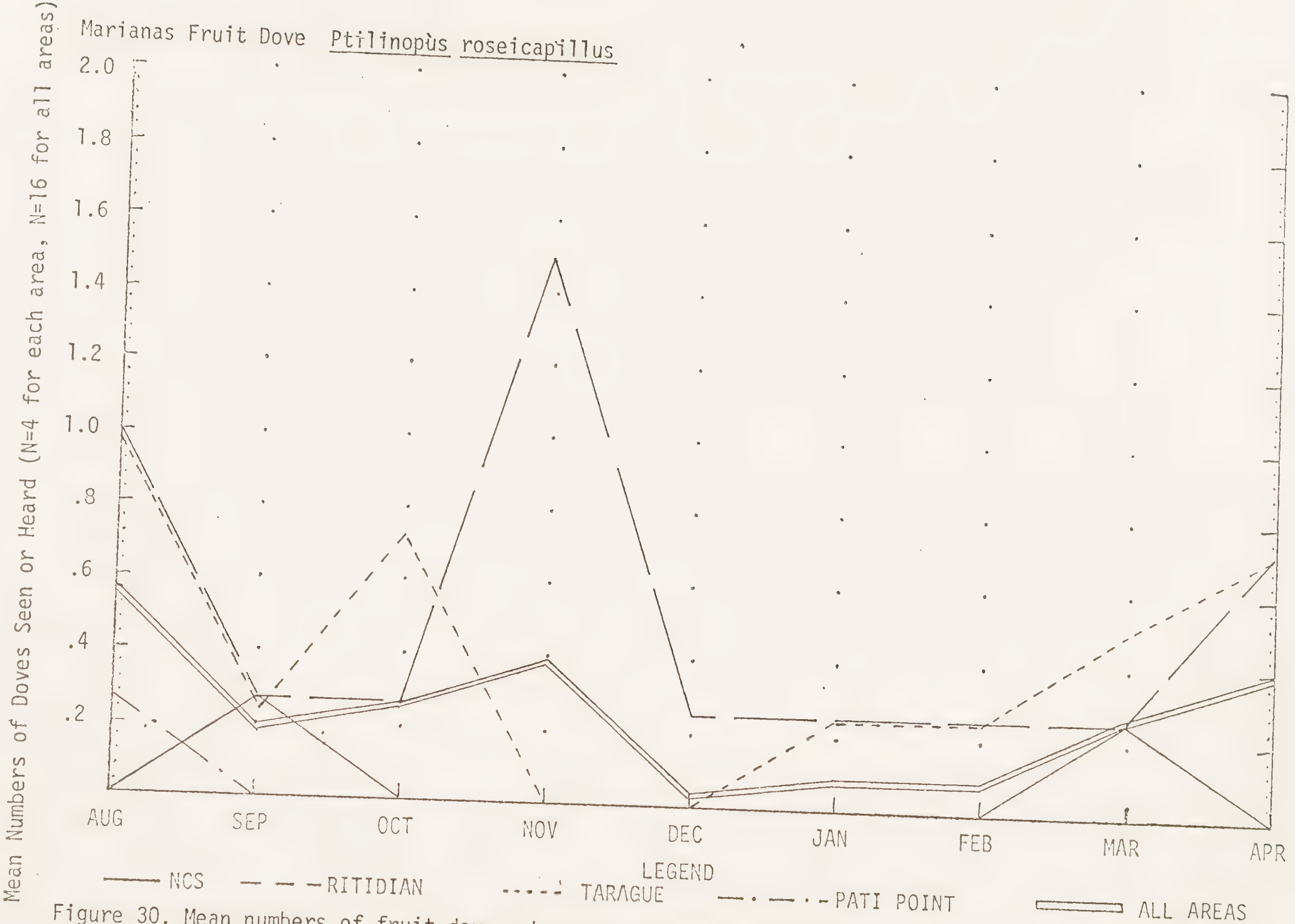

Figure 30. Mean numbers of fruit doves observed or heard during four 15-minute station counts.

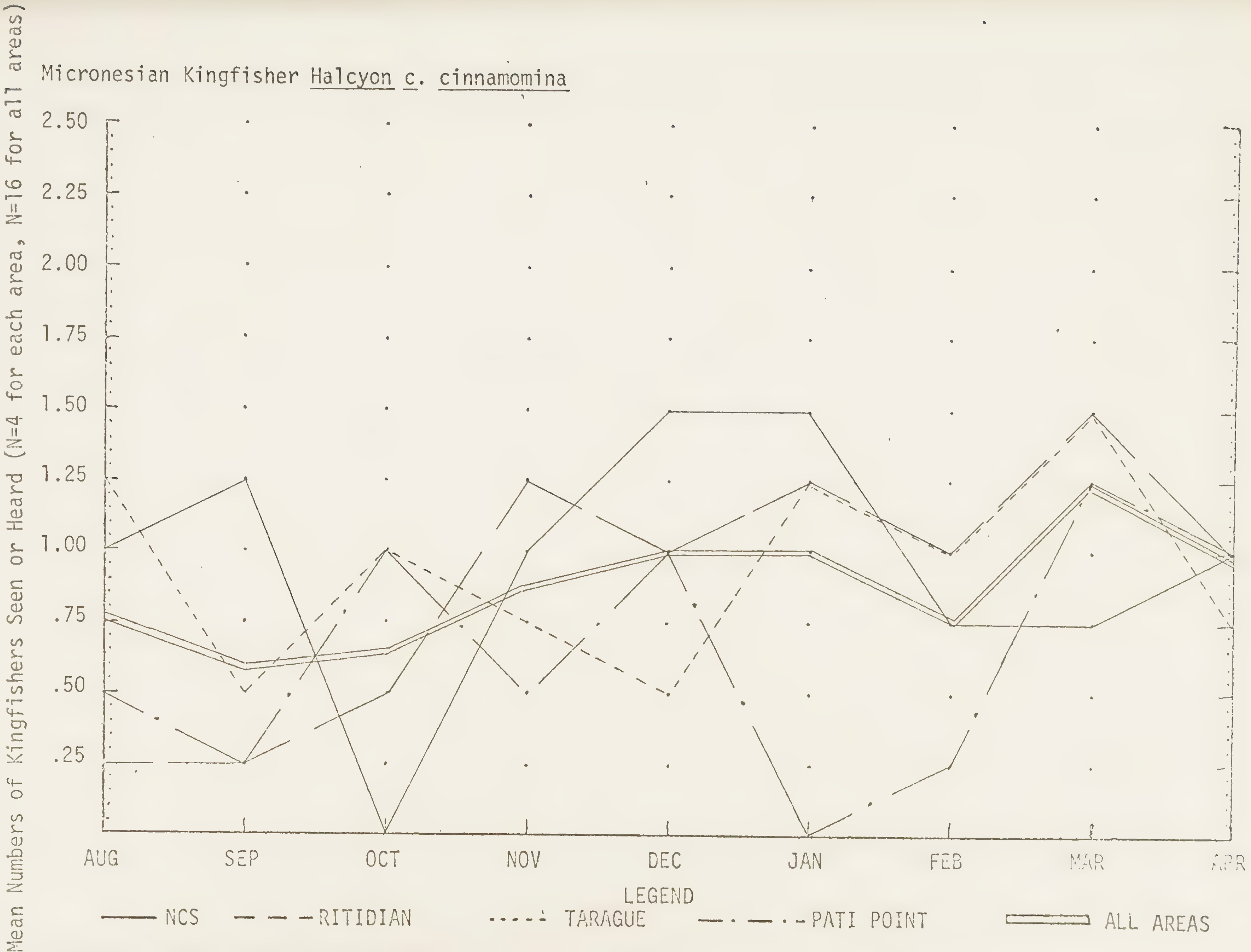

Figure 31 . Mean numbers of kingfishers observed or heard during four 15-minute station counts.

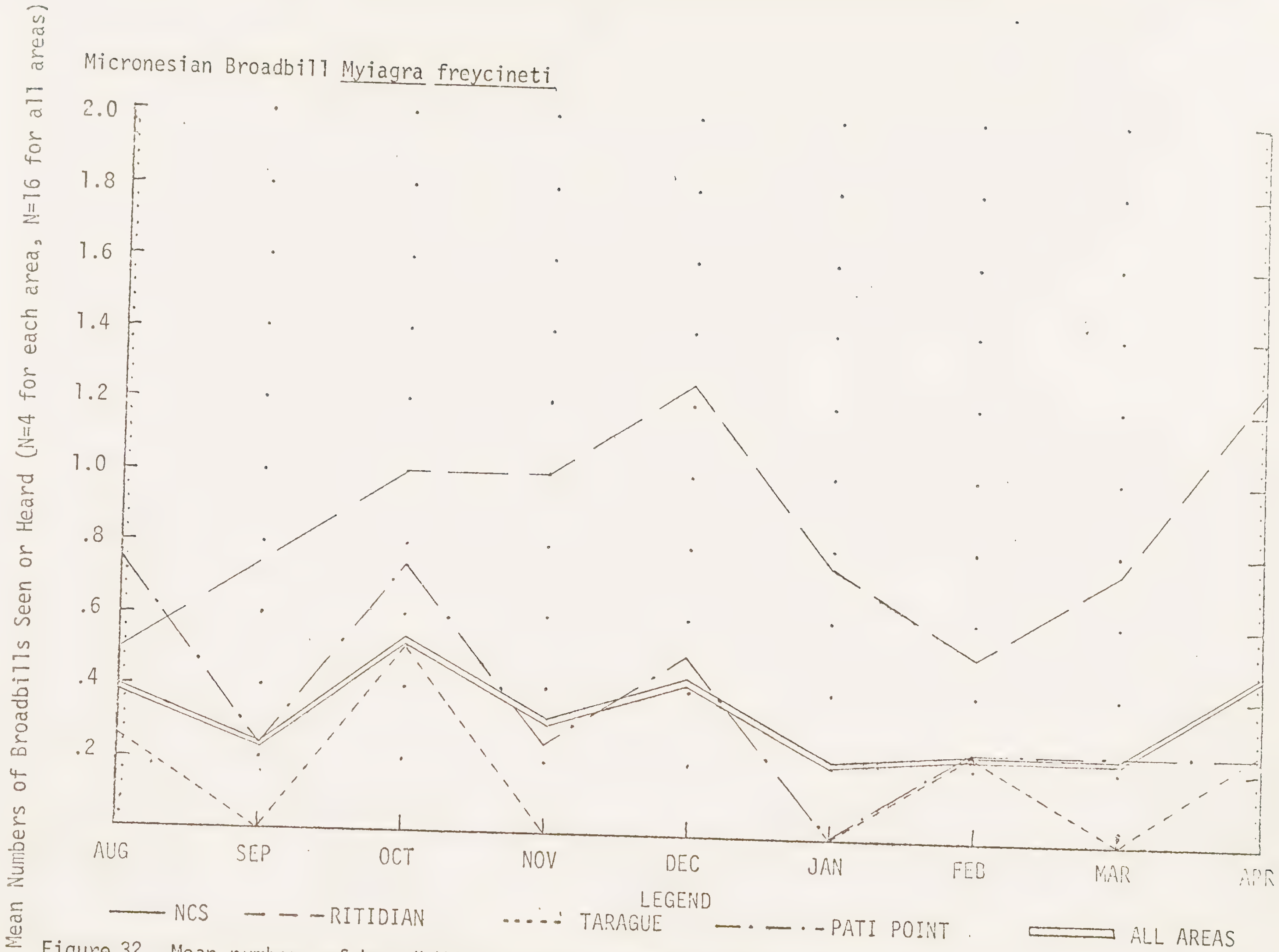

Figure 32. Mean numbers of broadbills observed or heard during four 15-minute station counts.

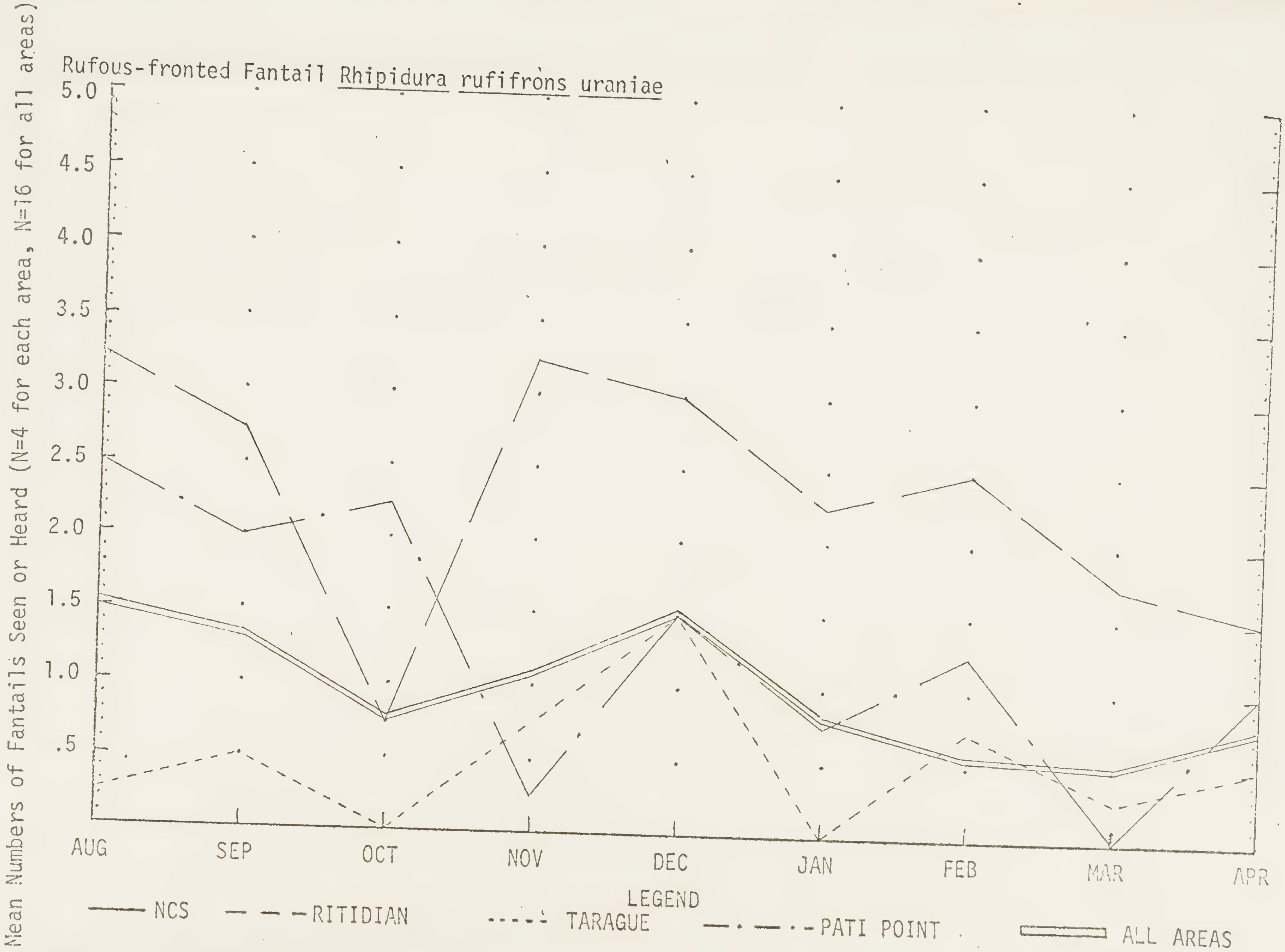

Figure 33. Mean numbers of fantails observed or heard during four 15-minute station counts

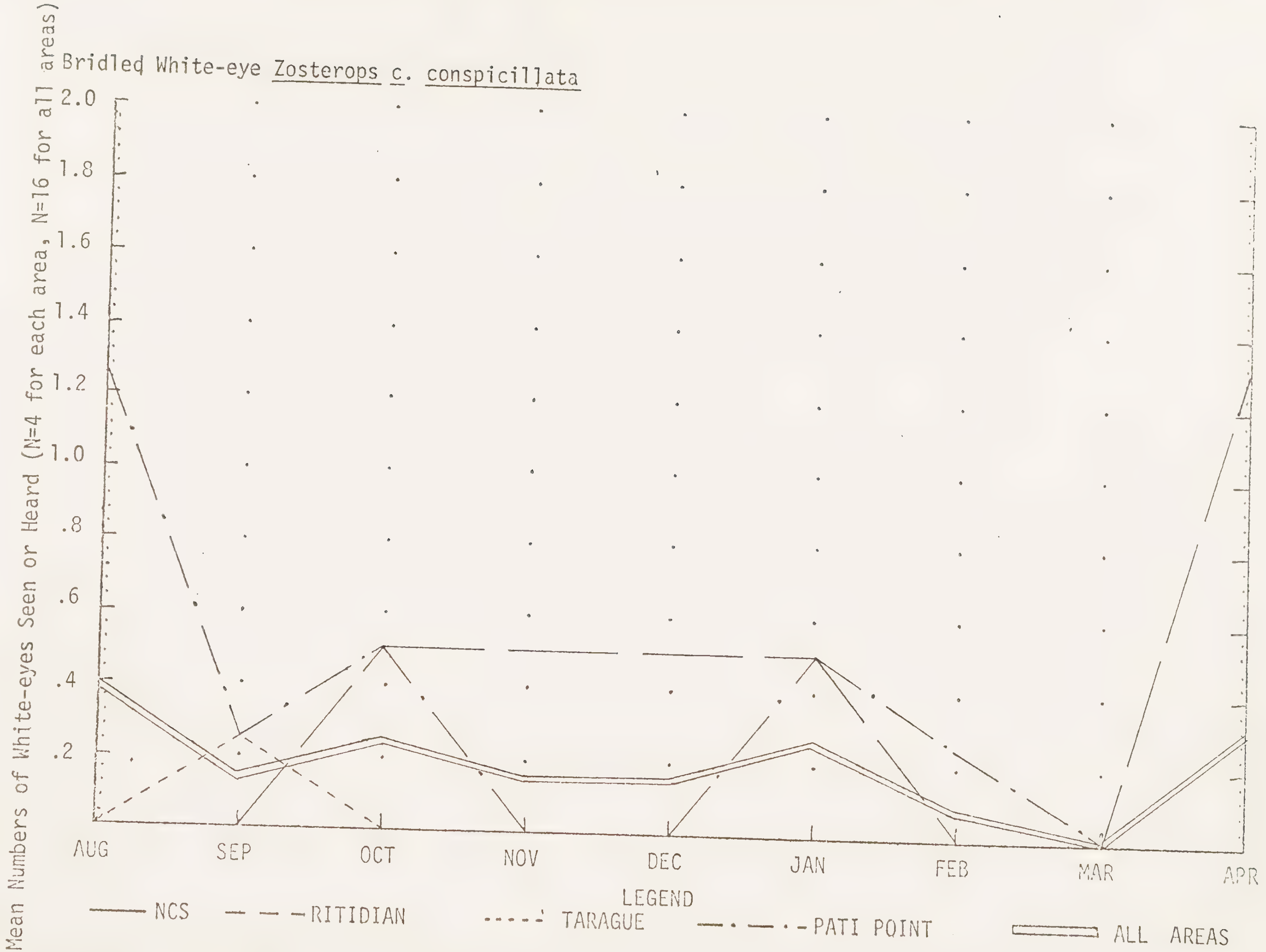

Figure 34. Mean numbers of white-eyes observed or heard during four 15-minute station counts.

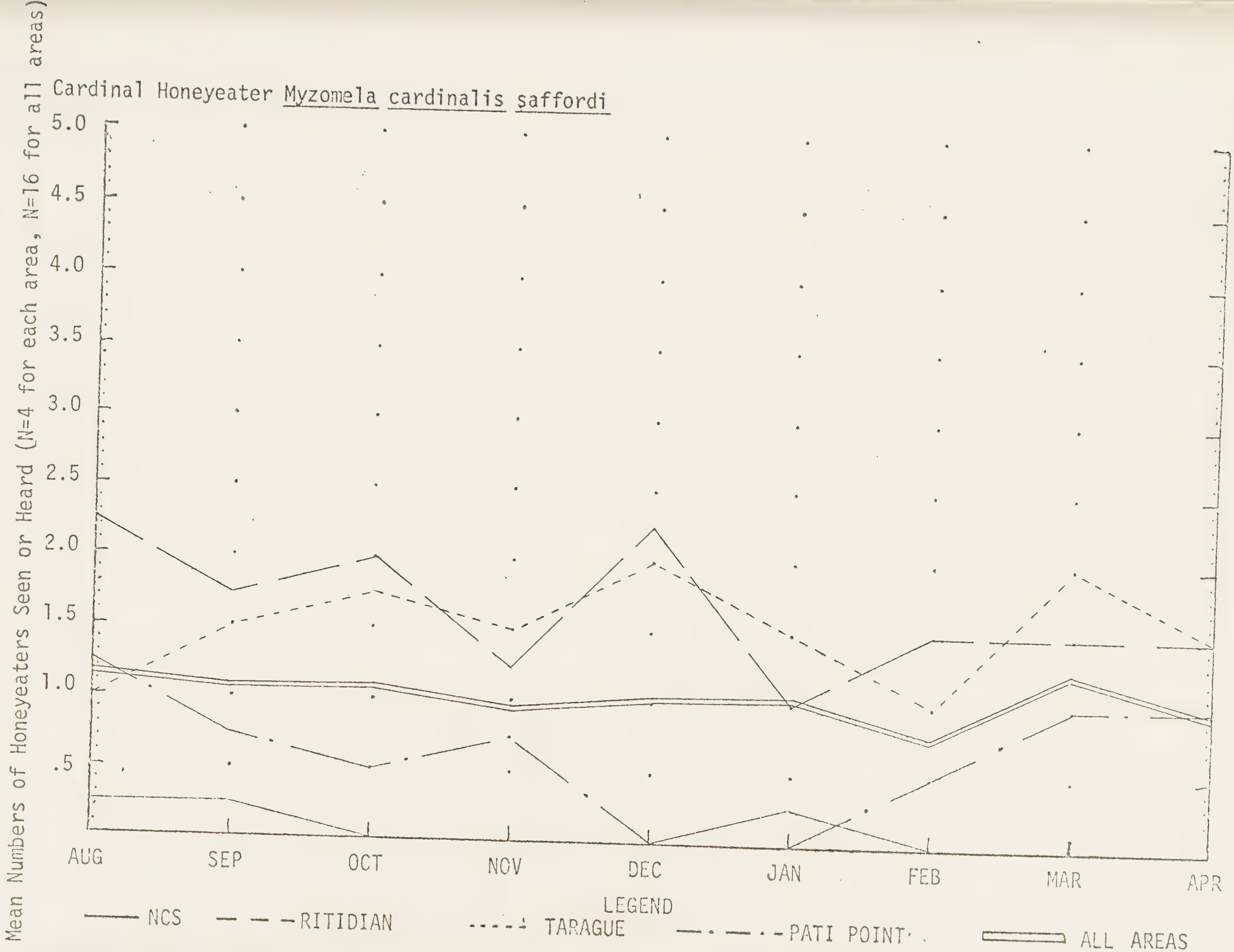

Figure 35. Mean numbers of honeyeaters observed or heard during four 15-minute station counts.

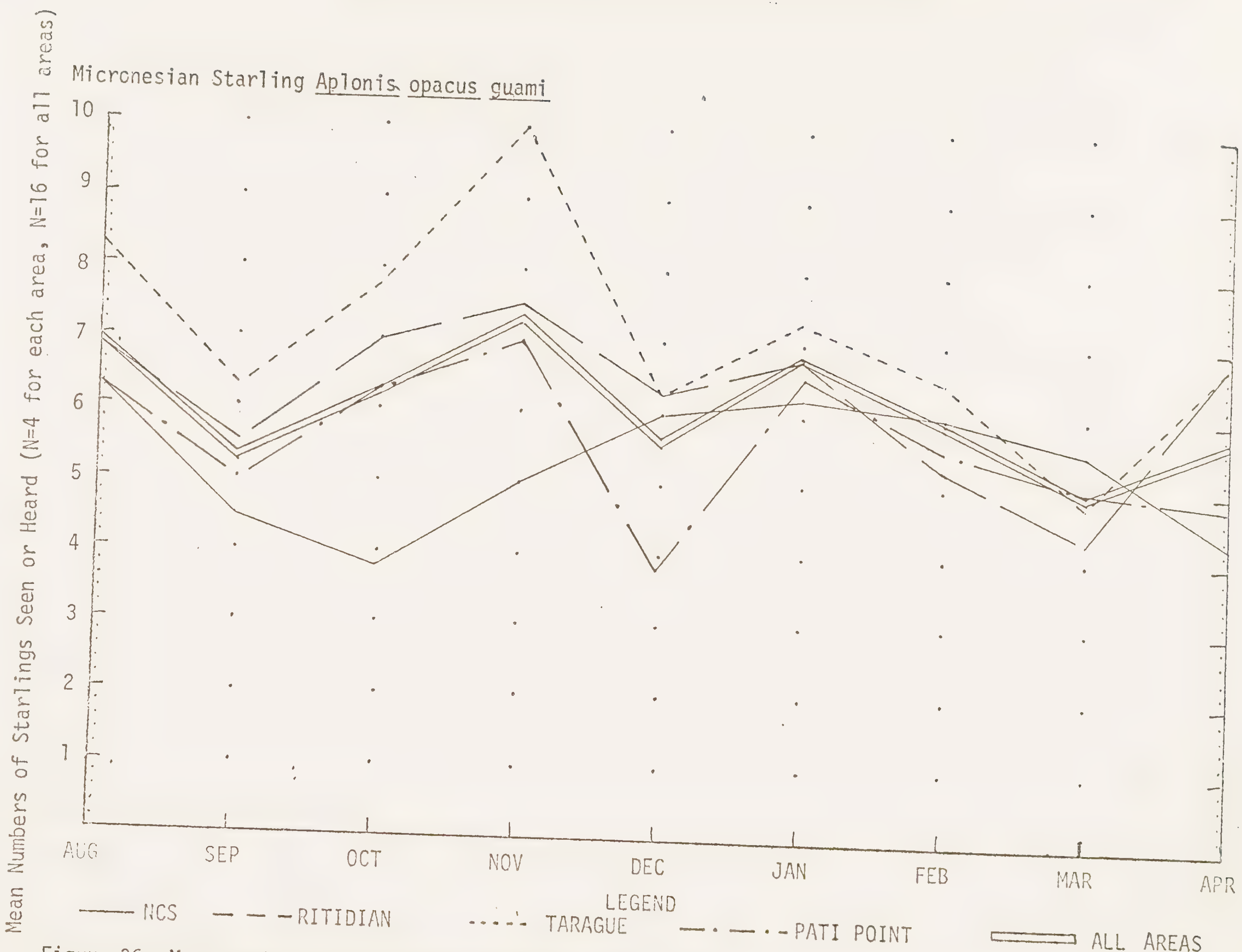

Figure 36. Mean numbers of starlings observed or heard during four 15-minute station counts.

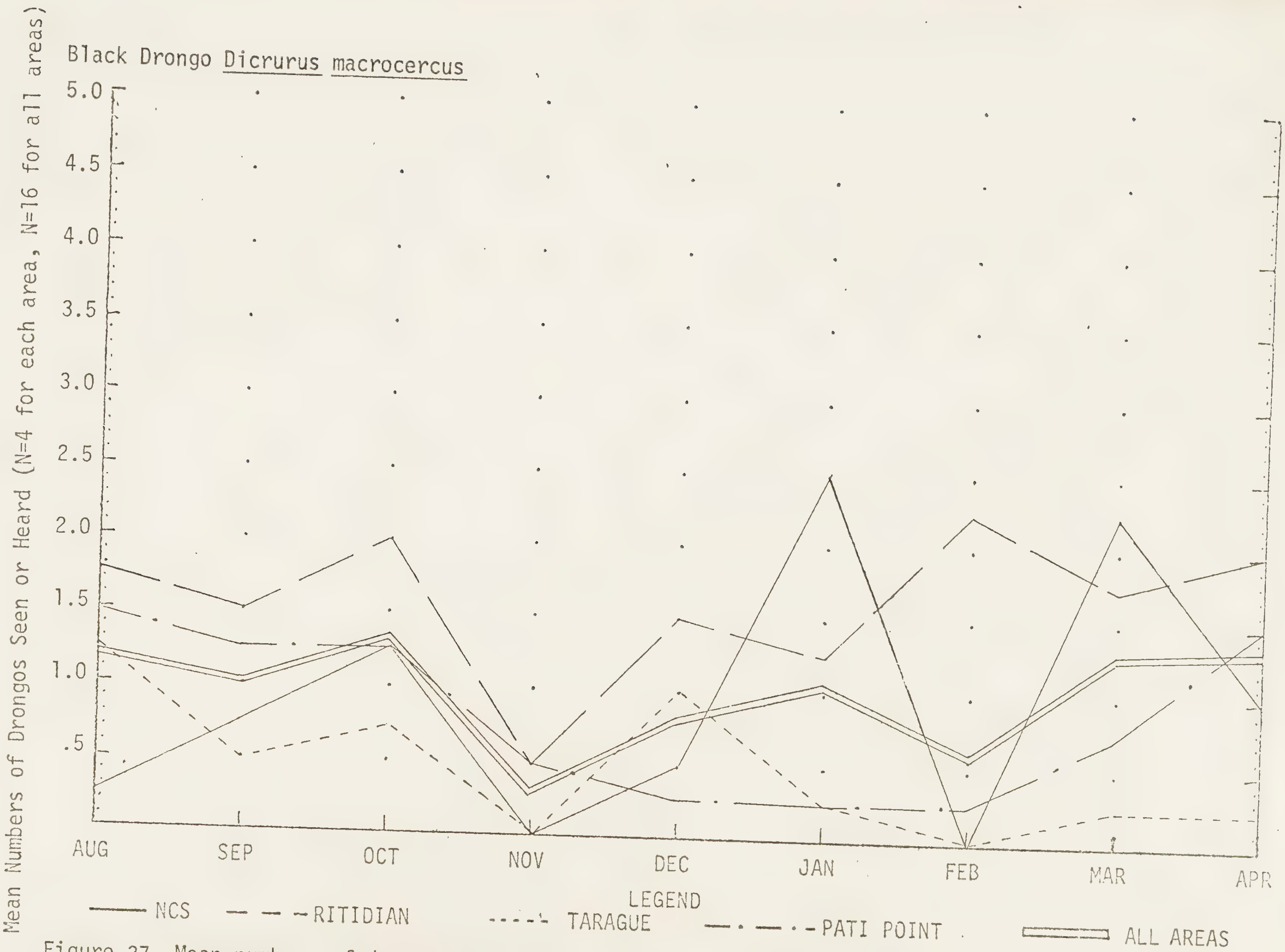

Figure 37. Mean numbers of drongos observed or heard during four 15-minute station counts.

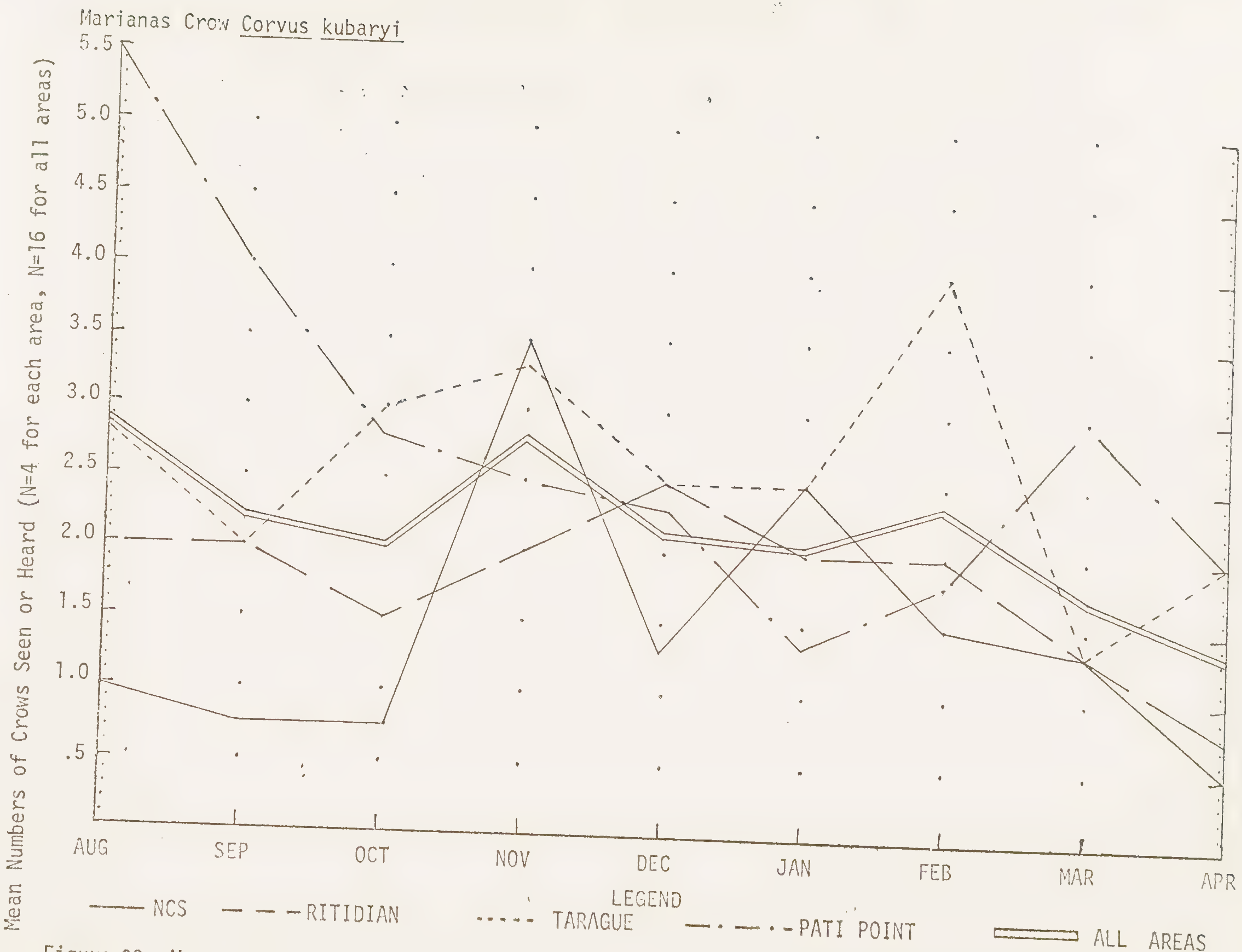

Figure 38. Mean numbers of crows observed or heard during four 15-minute station counts.

Table 3. The densities of forest birds in the northern limestone forest of Guam between August 1979 and April 1980.

	N	E.D.D.[1] (M)	DENSITY (Birds/ha) NCS	TARAGUE	RITIDIAN	PATI	MEAN
Micronesian Starling	834	15.4	74.2	74.2	95.2	72.0	79.5
Black Drongo	134	15.4	12.6	19.8	7.2	11.4	12.7
Philippine Turtle Dove	181	15.4	4.2	28.6	21.3	14.9	17.2
Marianas Crow	314	92.3	0.56	0.73	0.98	1.05	.83
Rufous-fronted Fantail	156	92.3	0	0.94	0.20	0.51	.41
Micronesian Kingfisher	125	123.1	0.22	0.19	0.20	0.14	.19
Cardinal Honeyeater	154	15.4	1.52	24.0	23.2	9.90	14.7
Micronesian Broadbill	44	153.8	0	0.10	0.02	0.05	.04
Marianas Fruit Dove	34	30.8	0.19	2.00	0.95	0.10	.81
White-throated Ground Dove	28	30.8	1.43	0.67	0.38	0.19	.67

[1] E.D.D. = effective detection distance (Reynolds et al. In Press).

Table 4. Interspecific associations between fruit bats and some birds.

	TWO BY TWO x^2	SIGNIFICANT AT P<.05	COEFFICIENT OF ASSOCIATION
Fruit Bat Vs. Black Drongo	.000018	No	-
Fruit Bat Vs. Philippine Turtle Dove	8.42	Yes	+.293
Fruit Bat Vs. Marianas Crow	1.19	No	-
Fruit Bat Vs. Micronesian Starling	9.73	Yes	+.315
Fruit Bat Vs. White-throated Ground Dove	.731	No	-
Fruit Bat Vs. Fruit Dove	11.01	Yes	+.106

Fruit Bats and Man. One of the major factors, if not THE major factor in determining fruit bat abundance in the Marianas is human predation. On Guam, where fruit bats are protected and hunting of them is illegal, poachers hunt at night when there is a full moon or crepuscularly under the cover of dense vegetation. To date the fruit bat study on Guam has identified areas of major concentrations of bats. Often at these places there has been a number of expended shotgun shells of a shot size suitable for taking bats. Data on fruit bat poaching is difficult to obtain, but given these observations it may be possible to develop an index of poaching by clearing large plots in bat habitat of all expended shotgun shells, and revisiting these plots at a later date to record the appearance of new shells. Coincident with an approach such as this sould be a continuous monitoring of fruit bat abundance on the island.

MANAGEMENT DIRECTIONS

From research conducted over the previous two years, a number of facts of the ecology of fruit bats seem equally applicable to the Marianas fruit bat and may be used in planning future management strategies. The Marianas fruit bat exploits plant communities that are in a late successional stage, close to climax; this assumption is supported by it's near restriction to mature forest. These fruit bats historically retained their population sizes through individual longevity, and low reproduction coupled with great parental investment. Their complex social behavior permits gregariousness and allows for a precise strategy for exploiting patches of habitat in space and time. Knowledge of areas of optimum food resource availability is transmitted to other individuals through this behavior complex.

Management directions should be aimed at preserving to the greatest possible extent the amount of mature forest habitat remaining in the Marianas. In addition, it is desirable to maximize the amount of energy and nutrients individual bats can spare from maintenance towards reproduction and growth. This involves ensuring full utilization and efficient conversion of nutrients to animal tissues. As Geist (1978) noted, the wildlife manager must be aware of and able to reduce inefficiencies in the utilization-conversion process, including unnecessary energy and nutrient expenditures. In regards to fruit bats such energy loss is greatest when the colony is disturbed, harassed or shot at. As pointed out by Geist, such harassment: "elevates metabolism at the cost of energy resources and reserves needed for the animal's normal growth and reproductive potential, ...can cause death, illness or reduced reproduction due to secondary effects from physical exertion and temporary confusion, (and) ...can lead to avoidance or abandonment of areas and to reduction in a population's range and, ultimately, to reduction of the population due to loss of access to resources, ...or increased energy cost for existence" (1978, pp. 287-289).

For these reasons efforts should be made to minimize or eliminate any human actions that could result in disturbance of colonial roosting fruit bats or fruit bats in general. Restricted areas maintained by the military, have been a major factor in preserving a remnant population of fruit bats on Guam. The security of these areas is sometimes breached and any efforts made to decrease the number of such incidents would not be wasted time. For some endangered raptor species on the U.S. mainland, nest watchers have been hired to protect a single nesting pair's reproductive effort from would-be thieves desiring an appropriate subject for falconry. Perhaps in the future if harassment by poaching of fruit bats continues to be a problem, it may be worthwhile to employ at bat colony guardian conservation officer to ensure that the colony (representing over 90% of Guam's fruit bat population) is not compromised. As for research efforts, enough ecological information is known to effectively manage Guam's fruit bat population to the extent now possible. It is desireable to continue systematic surveys to maintain a continuous knowledge of the abundance of fruit bats on Guam and to be able to document future population changes. Of low research priority would be a plan to mist net a few bats, equip them with radio transmitters and attempt to document movement patterns. From many observations of long distance flights of bats, I observed movement between Pati Point and the Tarague Beach area, between Tarague Beach and Jinapsan Beach area, between Jinapsan Beach and Ritidian Point, and between Pati Point and the terrace limestone forest on the east coast of Andersen Air Force Base. I strongly suspect movement between Ritidian and NCS. Fruit bats are commonly observed within a 1 km band along the coastline from Amantes Point to the Anao Conservation Area. From observations of long distance flights, it seems very probable that individual bats utilize much of this area over a period of several months. A telemetry study may document this to a greater accuracy, but it is unlikely that such information would lead to any new management decisions. Radio collaring bats that roost within the colony by day might be more useful if it could be done without disturbance to the colony. If the colony then moved and the collared bat remained with the colony, then the colony could be relocated by locating the collared bat, it seems likely that more effort would be expended in attempting to net, mark and track bats than would be required to search the field and find the colony by more conventional means. Future research efforts should take into consideration man-power costs and returns of ecological information in planning future study.

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Appendix. Relative frequencies of twenty dominant limestone forest plants.

SPECIES	NCS	RITIDIAN	TARAGUE	PATI POINT
Pandanus fragrans	.180	.071	.185	.018
Agalaia mariannensis	.059	.130	.080	.186
Neisosperma oppositifolia	.102	.142	.115	.126
Premna obtusifolia	.140	.065	.125	.030
Morinda citrafolia	.102	.112	.080	<.006
Cycas circinalis	.062	.059	.060	.060
Cestrum diurnum	.059	<.018	.065	.108
Triphasia trifolia	.059	.089	.050	<.006
Wikstromea elliptica	<.008	.030	.050	.108
Macranga thompsonii	.039	.047	<.005	.084
Carica papaya	.055	.036	.040	.012
Psychotria mariaha	<.008	.036	<.005	.042
Pipturus argenteus	<.008	.041	.010	.012
Ochrosia mariannensis	<.008	.030	<.005	.066
Ficus prolixa	.012	.030	.030	.036
Artocarpus mariannensis	.039	<.018	.010	<.006
Guamia mariannae	.043	.030	.070	.096
Eugenia reinwardtiana	.016	<.018	<.005	.006
Melanolepis multigrandulosa	.016	.036	.025	<.006
Eleocarpus sphaericus	.008	.018	.005	<.006

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Movement Patterns and Habitat Utilization of Marianas Fruit Bats in the Mariana Islands.

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To determine movement and activity patterns, home range size, and patterns of habitat utilization, with an emphasis upon roost site fidelity and inter-island migration.

RESULTS

This job was inactive during this segment pending development of adequate facilities for holding bats in captivity.

RECOMMENDATIONS

This job should be implemented in Segment 18 if adequate manpower is available and if animal-holding facilities can be developed through W-D-2.

Report Prepared by Robert D. Anderson

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 2 Recovery and Management of the Native Doves of Guam

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management Plan for the Native Doves of Guam

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To develop a recovery program and species management plan for the native doves of Guam.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 18 if adequate manpower is available.

Report prepared by Robert D. Anderson

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 3 Recovery and Management of the Guam Rail

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 3
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management Plan for the Guam Rail

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To develop a recovery program and species management plan for the Guam rail.

PROCEDURES

1. Prepare a status report on the Guam rail.
2. Publish completed manuscript on the "Natural History of the Guam Rail".
3. Identify management and research needs and make recommendations for future work.

RESULTS

This job was completed during the segment and the final report published as:

> Jenkins, J. Mark. 1979. Natural history of the Guam rail. Condor 81:404-408.

This paper is based upon rail data collected by the Division since 1960 and includes recommendations for protection and management of the Guam rail and identifies future research needs.

Report Prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 3
JOB NO.: 2

JOB TITLE: Identification and Acquisition of Land Useful as Guam Rail Habitat

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

Steps have been taken to acquire and protect certain land areas that have value as habitat for the Guam Rail.

BACKGROUND

The Guam rail is a flightless, endemic bird species formally distributed island-wide. Numerous factors including rapid island development, predation, pesticides, military operation during World War II and possible avian disease are suspected in contributing to the rail's recent decline. Guam rails are now concentrated in small areas of the northern plateau and total population size is estimated at 3,000 to 5,000 individuals. In order to help prevent further decline, it was decided to acquire suitable rail habitat to be protected as conservation areas.

In 1977, the Department of Defense (DOD), through the Navy and the Air Force, completed a study of all DOD owned land on Guam. This study was designed to determine future DOD land requirements, examine joint-use of land and facilities for more efficient real-property utilization, and what DOD land holdings could be released in concurrence with Executive Order 11954. This study resulted in a document entitled "Guam Land-Use Plan: A plan for Department of Defense Real Estate in Guam.

This report identified 2625 acres as available for immediate release and 2555 acres to become available in the future. It also stipulated that all land transfers be accomplished through established U.S. Government procedures.

The Bureau of Planning, Government of Guam, was assigned to act as the lead agency in coordinating the transfer of excess federal lands. All Government of Guam agencies were instructed to review the Land-Use Plan and identify those releasable lands which were needed by them for support of their programs.
The Bureau of Planning then evaluated all the departmental requests and determined the proper procedure to acquire each parcel. Upon receiving completed land transfer applications from each agency, the Bureau of Planning acted as arbitrators and determined the best use of land in cases of multiple or conflicting use

proposals. Military lands identified as best suited for conservation use were assigned to the Division of Aquatic and Wildlife Resources (DAWR) for preparation of the land transfer applications.

Concurrent with the above process, the Division submitted recommendations to list ten species of native birds (including the Guam rail) as endangered under the Endangered Species Act of 1973. These proposals are under active consideration by the U.S. Fish and Wildlife Service and the Division consequently has submitted detailed proposals to designate critical habitat for each of the endangered species candidates. Military land currently being applied for falls within land designated as critical habitat for the Guam rail.

OBJECTIVES

To set aside and protect valuable Guam rail habitat using existing legal authoritie

PROCEDURES

1. Identify and attempt to acquire land that provides habitat for the Guam rail.
    a. Designate selected areas of Government land as "Agricultural Preserves" for the purpose of protecting rail habitat and acquire excess federal lan as it becomes available to the Government of Guam.
    b. Designate selected areas of private land as "Agricultural Preserves" and enter into contracts with the owners for the protection of rail habit
2. Recommend areas to be designated as "Critical Habitat" under the Endangered Species Act of 1973.

RESULTS

The Bureau of Planning has allocated in excess of 1600 acres of prime rail habitat under either Navy or Air Force jurisdiction to conservation use (Figure 1). Applications for the transfer of these lands have been prepared and submitted to the Bureau of Planning. Because this land transfer will be for wildlife conservation, it is expected that the Government of Guam can acquire this land at no cost and action is expected during 1981.

Although the Division has been working to acquire these lands for habitat protectio ultimately these lands are to be declared either nature preserves or conservation reserves, and incorporated in the Territorial Park System. This would provide necessary protection and yet preclude this Division from having landlord responsibilities. The DAWR will retain responsibility for the management and protection of wildlife, including the Guam rail.

In addition, we have requested and received a legal interpretation of the "Guam Land Conservation Act" from the Attorney General. This law provides for the creation of "Agricultural Preserves" on either public or private lands that meet certain criteria. The intent of this law is to protect agricultural land, wildlife resources and natural open spaces from development that may be incompatibl

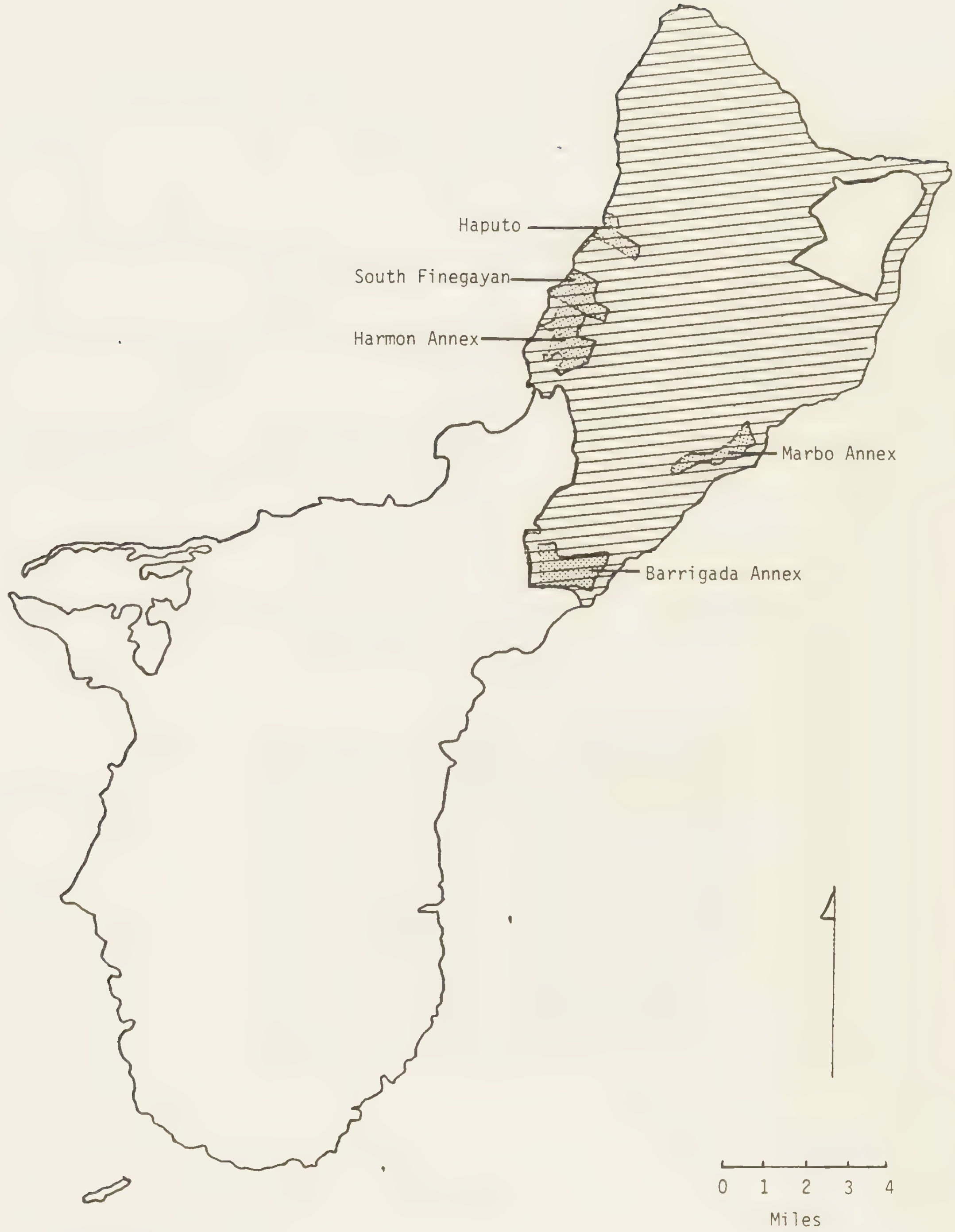
Haputo
South Finegayan
Harmon Annex
Marbo Annex
Barrigada Annex
0 1 2 3 4
Miles

Figure 1.

▩ Releasable federal land designated for conservation use

▤ Area recommended as Critical Habitat for the Guam rail with these preserves. Private land may be made into "agricultural preserves" by entering into a contract with the landowner. Such contracts provide for the protection of the resources from development for the life of the contract; landowners benefit by receiving a tax deferral of 50% of the value of the land. This law, which has not yet been utilized, has considerable potential for providing protection to certain areas that have high wildlife habitat value.

This Division has also recommended those areas in which rails are now concentrated be declared "Critical Habitat" by the U.S. Fish and Wildlife Service (Figure 1). This proposal is currently under consideration and should be acted upon shortly.

RECOMMENDATIONS

1. To continue with current requests for the acquisition of designated excess military land for protection of Guam rail habitat.
2. To attempt to designate selected areas of private land as "Agricultural Preserves" and enter into contracts with private land owners for protection of rail habitat.
3. To work closely with the Territorial Park System in declaring acquired conservation areas "Nature Preserves" or "Conservation Preserves," to be managed by the Territorial Park System.

Report Prepared by: Robert D. Anderson and Anne F. Maben

Guam rail

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 4 Recovery and Management of the Guam Gallinule

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 4
JOB NO.: 1

JOB TITLE: Development of a Species Management and Recovery Plan for the Guam Gallinule

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To develop a species management and recovery plan.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 19 if adequate manpower is available.

Report prepared by Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 4
JOB NO.: 2

JOB TITLE: Gallinule Habitat Survey and Protection

PERIOD COVERED: October 1, 1979 through September 30, 1980

SUMMARY

Steps have been taken to acquire and protect certain wetlands habitat that have value as habitat for the Guam gallinule.

BACKGROUND

The Guam gallinule (*Gallinula chloropus guami*), a subspecies of the common gallinule, is endemic to the Marianas. Currently a candidate for the federal Endangered Species List, it was once abundantly distributed throughout wetlands on Guam (Baker, 1951).

A loss of suitable habitat may be a major reason for this species decline. Common gallinule densities have shown to be the highest with a 50:50 ratio of cover to open water (Brackney, 1979; Wetler and Spatcher, 1965); these ideal habitat conditions being found in decreasing numbers in recent years. Taro and rice, once widely cultivated, no longer are grown as major crops and cease to provide suitable wetland habitat (Antonio Quitugua, per comm.). Agana Swamp and Agana Springs, once major breeding areas for gallinule, are currently choked with reeds and appear unsuitable to gallinules in their present state. Other factors, such as pesticides, predation, avian disease, rapid island development, and military operations during World War II may also be affecting gallinules.

Gallinules are now concentrated on Fena Resevoir, with small populations on Masso Reservoir, Agana Swamp, Agana Springs, the Marianas Terrace ponding basin, and a few small, privately owned ponds. Given suitable habitat, however, the Guam gallinule appears highly adaptable and has recently been observed raising broods successfully in areas as small as ½ acre ponds at two locations in Mangilao. In order to help prevent further population decline, it was decided to acquire appropriate gallinule habitat to be improved and protected as conservation areas.

In 1977, actions were initiated by the Department of Defense that resulted in the identification of large areas of excess military land as releaseable to Government of Guam agencies for the support of their programs. As detailed in Job W-5-3-2 (Rail Habitat), the Division of Aquatic and Wildlife Resources submitted land transfer applications for those releasable military lands identified as best suited for conservation use. Among these were applications for acquiring Masso Reservoir and Agana Springs, both identified as critical habitat for the Guam gallinule in proposals currently under consideration by the U.S. Fish and Wildlife Service.

OBJECTIVE

To set aside and protect valuable Guam gallinule habitat using existing legal authorities.

PROCEDURES

1. Identify and attempt to acquire land that provides habitat for the Guam gallinule.
    a) Designate selected areas of private land as "Agricultural Preserves" and enter into contracts with the owners for protection of gallinule habitat.
    b) Designate Masso Reservoir and Agana Springs as "Agricultural Preserves" for the purpose of protecting gallinule habitat and acquire excess federal land as it becomes available.
2. Recommend areas to be designated "Critical Habitat" under the Endangered Species Act of 1973.

RESULTS

The Bureau of Planning has designated Masso Reservoir and Agana Springs, both potentially areas of prime gallinule habitat, for conservation use (Figure 1). Applications for the transfer of these lands have been prepared and submitted to the Bureau of Planning. Because this land transfer will be for wildlife conservation, it is expected that the Government of Guam can acquire this land at no cost and action is expected during 1981.

Although the Division has been working to acquire Agana Springs and Masso Reservoir for habitat protection, ultimately these areas will be declared either nature preserves or conservation preserves and incorporated into the Territorial Park System. This will provide necessary protection and precludes this Division from having landlord responsibilities. The DAWR will retain responsibility for the management and protection of wildlife, including the Guam gallinule.

In addition, we have requested and received a legal interpretation of the "Guam Land Conservation Act" from the Attorney General. This law provides for the creation of "Agricultural Preserves" on either public or private lands that meet certain criteria. The intent of this law is to protect agricultural land, wildlife resources and natural open spaces from development that may be incompatible with these preserves. Private lands may be made into "Agricultural Preserves" by entering into a contract with the landowner. Such contracts provides for protection of these resources from development for the life of the contract; landowners benefit by receiving a tax deferral of 50% of the value of the land. This law, which has not been utilized,

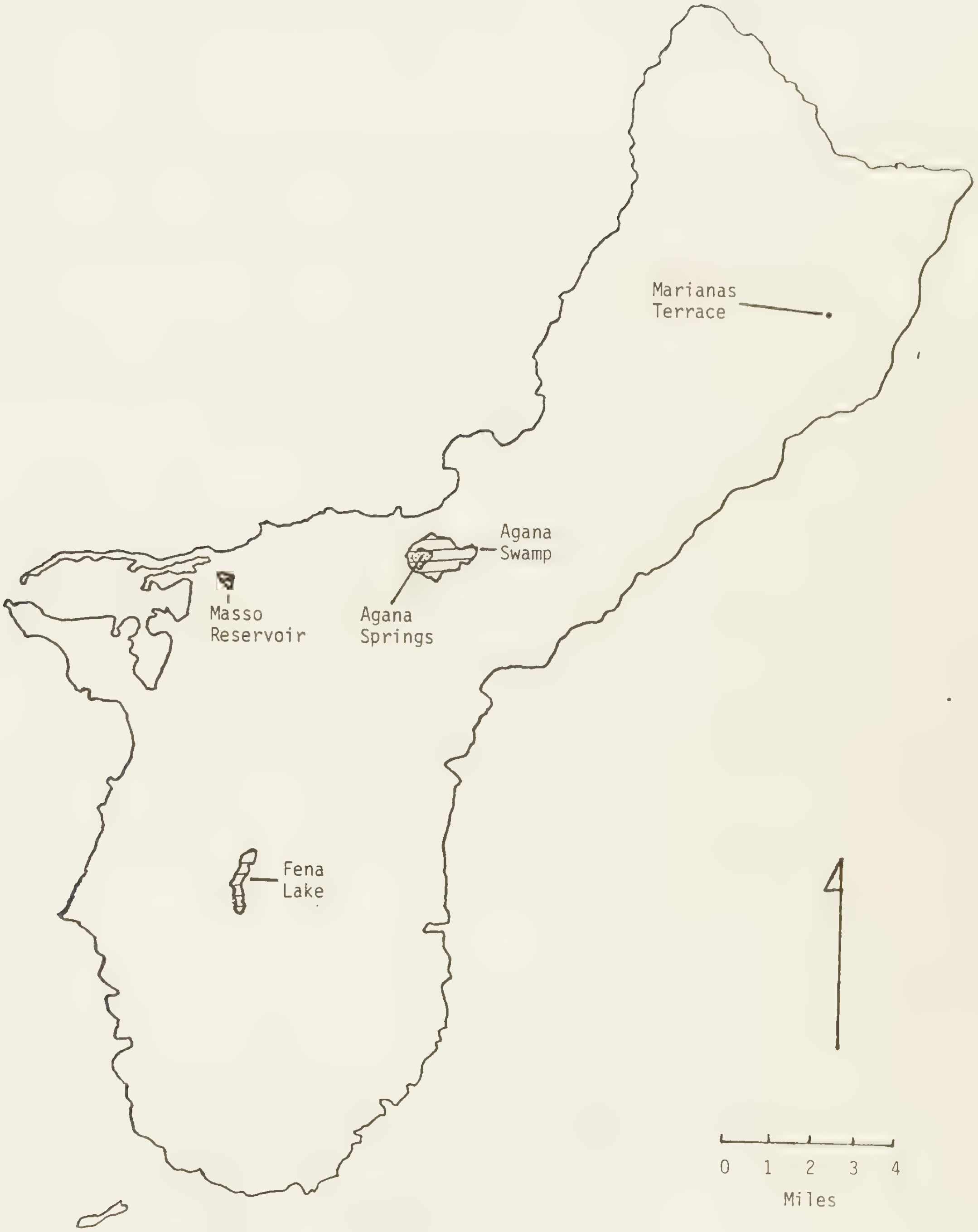
Marianas Terrace
Agana Swamp
Masso Reservoir
Agana Springs
Fena Lake
0 1 2 3 4
Miles

Figure 1.

░ Releasable federal land designated for conservation use

▨ Area recommended as Critical Habitat for the Guam gallinule has considerable potential for providing protection of certain areas that have high wildlife habitat value.

The DAWR has also recommended these areas in which Guam gallinules are now concentrated be declared "Critical Habitat" by the U.S. Fish and Wildlife Service (Figure 1). This proposal is currently under consideration and should be acted upon shortly.

RECOMMENDATIONS

1. To continue with current requests for the acquisition of designated excess military land for protection of Guam gallinule habitat.
2. To attempt to designate selected areas of private land as "Agricultural Preserves" and enter into contracts with private land owners for protection of gallinule habitat.
3. To work closely with the Territorial Park System in declaring acquired conservation areas "Nature Preserves" or "Conservation Preserves" to be managed by the Territorial Park System.

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Weller, M.W. and C.S. Spatcher. 1965. The role of habitat in the distribution and abundance of marsh birds. Iowa State University. Agri. Home. Econ. Exp. St. Spec. Rep. 43.31 pp.

Report Prepared by: Anne F. Maben

Guam gallinule

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 5 Recovery and Management of the Vanikoro Swiftlet on Guam

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 5
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management Plan for the Edible-Nest Swiftlet

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To develop a status report and species management plan for the edible-nest swiftlet.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job should be implemented in Segment 18 if adequate manpower is available.

Report Prepared by Robert D. Anderson

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 6 Impact of Introduced Predators on Native Bird Populations

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R17
SUB-PROJECT NO.: W-5
STUDY NO.: 6
JOB NO.: 1

JOB TITLE: Literature Review and Planning of Predation Study

PERIOD COVERED: October 1, 1979 to September 30, 1980

SUMMARY

A literature search and review was conducted concerning predation on native birds. Programs were designed to measure the impact of predation and investigate pertinent aspects of island predator's life histories and food preferences.

BACKGROUND

Guam's native bird populations have fallen drastically, particularly in the last ten years. The ten species of birds currently candidates for the federal Endangered Species list are confined mainly to the northern cliffline limestone forest. The three native bird species already federally listed as endangered are almost certainly extirpated from Guam, although they are still found in the Northern Mariana Islands. All native birds were historically found island-wide yet only two species of native land birds can now routinely be found in southern Guam.

Though numerous factors such as environmental contaminants, avian disease and destruction of habitat may be factors in these species' decline, there is evidence predation may play a major role. The native birds of Guam evolved in a predator-free, insular environment. Under these conditions, the Guam rail (*Rallus owstoni*) lost its ability to fly and other birds, such as the Marianas fruit dove, became relatively weak fliers. Today, introduced predators such as dogs, cats, three species of rats, pigs, the monitor lizard (*Varanus indicus*) and the Philippine rat snake (*Boiga irregularis* are widespread and may have a significant impact on native wildlife.

Little quantitative work has been done to date to discover predator's feeding preferences, distribution, movement patterns, or life histories. Although it is known the Philippine rat snake was accidently introduced around 1947, little has been done to document its spread or impact other than anecdotal observations in DAWR field notes and discussions with local residents. The monitor lizard has been present on Guam since the period of Spanish rule and possibly earlier, yet little research has been conducted concerning its present effect on depressed bird populations (Dryden, 1965; Uchida, 1965; Gardner, 1978).

Cats, dogs, and pigs have also been on Guam since Spanish times, however, burgeoning human population and the transitory nature of the military and some civilian government employees have added to a dramatic increase in feral animal numbers. Packs of dogs are common and have been known to pull down prey as large as a Guam deer. Informal observations by local residents attest to feral animals' fondness for chickens and eggs. In an effort to determine to some degree the effect these predators may be having on Guam's wildlife, several research programs are being designed.

PROCEDURES

1. Conduct a literature search on predation, emphasizing research techniques and the impact of predation on birds by animals similar to Guam's.
2. Review and document each predators introduction to Guam and its subsequent spread throughout the island.
3. Design experimental programs to measure the impact of predation on both arboreal and ground-nesting birds.

RESULTS

A literature search has been conducted using the computer facilities of the Pacific Islands Institute of Forestry and research at mainland university libraries. Information concerning life histories and feeding preferences of island predators is continuing to be collected and synthesized.

Past DAWR field notes have been searched for any information concerning the introduction and subsequent spread of predators on Guam. Articles in newspapers and journals available at the Micronesian Area Research Center have also been studied. Local residents are being approached in all areas of Guam for past and present information on feeding habits and distribution of all predators.

An Application for Federal Assistance (AFA) has been submitted for funding through Guam's Endangered Species Cooperative Agreement under Section 6 of the Endangered Species Act of 1973. If approved, this AFA will provide funds for certain predation-related studies. In view of the scarcity of information on Guam's reptilian predators, a project is planned that will entail hiring a biologist knowledgeable in herpetology. Suggested studies include stomach and fecal sample analysis, telemetry tracking to determine range and activity patterns and in-depth studies designed to reveal abundance, density, distribution and reproductive biology. As part of the initial phase of this project we have examined 32 snakes: of these, eighteen contained no prey items, five contained eggs, six contained birds, two contained lizards, and one had eaten a rabbit. We have also received reliable reports of snakes having killed small puppies and young goats. Snakes examined varied in length between approximately 3 ft. to over 8 ft.

Studies are also being designed to address the effects of predation on the birds themselves. One planned study will attempt to evaluate predation impacts on ground nesting birds such as the Guam rail. Rail populations in limestone forest, agriculture land, and disturbed open areas will be color banded for individual recognition. Daily and seasonal movement of color-marked birds will be monitored and activity patterns observed. Experimental dummy nests using quail eggs may be established and monitored to evaluate the incidence of nest predation in each area (Picozzi, 1975). Additional investigations will be designed to monitor reproductive activity and brood success in rails.

RECOMMENDATIONS

1. Continue to research literature on predation and Guam's major predators' life histories and feeding habits.
2. Hire a herpetolagist to research the important aspects of the biology, life histories, and habits of the Philippine rat snake and the monitor lizard.
3. Design and implement a study on arboreal nest predation.
4. Continue to conduct a study researching the impact of predation on the Guam rail.

LITERATURE CITED

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Gardner, David. 1978. The monitor lizard: our Micronesian dinosaurs. Pacific Daily News, Jan. 28, pp. 4-6.

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Report Prepared by Anne F. Maben

Philippine rat snake

Guam Wildlife Investigations
Project FW-2R-17

Federal Aid in Wildlife Restoration Act

Sub-project W-5 Threatened and Endangered Species
Study 7 The Impact of Pesticide and Herbicide Use on Wildlife Populations

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 7
JOB NO.: 1

JOB TITLE: Development of a Study to Determine the Past and Present Impact of Pesticides on Guam's Wildlife Population

PERIOD COVERED: October 1, 1979 through September 30, 1980

SUMMARY

Background information on pesticide useage on Guam has been gathered from both civilian and military sources, and further research has been planned. Proposed pesticide research programs include assistance from the Patuxent Wildlife Research in designing and implementing detailed pesticide studies.

BACKGROUND

Population levels of Guam's native wildlife species have declined sharply in recent years. Three species of native birds, the Micronesian megapode (Megapodius laparouse), the Marianas mallard (Anas oustaleti), and the nightingale reed-warbler (Acrocephalus l. lucinia) are listed as endangered under the federal Endangered Species Act of 1973 and may already be extirpated on Guam. Proposals to list an additional ten species of native birds and two species of bats are currently being considered by the U.S. Fish and Wildlife Service.

Historically, pesticides and herbicides since World War II have played an important role in agriculture and disease control. DDT was applied to most areas of Guam both by hand and by plane as frequently as once a week for several years after the war (Baker, 1946). Body tissues of swiftlets analyzed for DDT and DDE in 1975 showed a mean concentration of .27 ppm (DDE). (Drahos, 1977).

In 1975, the threat of an outbreak of dengue fever among thousands of Vietnamese refugees forced the military to spray approximately 1/3 of the island at treetop level four times with Malathion. Fish were killed in several bays on Guam immediately following each application (Haddock, et al, 1979). The nightingale reed-warbler, an insectivore existing in extremely small numbers in the Agana Swamp, has not been reported since 1975 (DAWR field notes).

Naval and Air Force bases on Guam, although discontinuing applications of chlorinated hydrocarbons in the early 1970's (Tom Lauret, pers, comm.) still apply Malathion around buildings and beaches up to three times a week and Diuron 80, an herbicide, along pipelines and storage areas yearly (Capt. Buddy Caples, pers. comm.). While the effect of low persistence insecticides on wildlife populations is not clear, some may have an impact on breeding behavior or readiness, even if no direct physiological changes are involved (Moulding, 1976).

Agricultural use of pesticide and herbicides both on public and private land is not strictly controlled, although types and quantities of chemicals imported are monitored by the Guam Environmental Protection Agency (GEPA). Suggested doses are given for each chemical but final application is up to the discretion of the farmer. Sevin appears to be the most frequently applied pesticide, followed by Malathion, Dibrom, and Diazinon. Runoff and careless application appear to be potential sources of pesticide contamination on Guam. As many family-run farms are located near northern limestone forests, pesticides and herbicides may still pose a threat to Guam's precarious wildlife populations (GEPA, 1979).

OBJECTIVE

To develop a study to determine the past and present impact of pesticides on Guam's wildlife populations.

PROCEDURES

1. Review literature regarding the impacts of environmental contaminants on wildlife.
2. Investigate and document the historical use of pesticides, herbicides, and other environmental contaminants on Guam and other islands in the Northern Marianas, including types and amounts used, location and timing of application, and current levels of usage.
3. Contact military and civilian agencies currently responsible for conducting pesticide research and analysis, implementing pest and weed control programs, and monitoring the use of pesticides, and other chemicals on Guam.
4. Select appropriate target species on Guam and design a research program to investigate the impact of pesticide and other environmental contaminants on Guam's native wildlife.

RESULTS

All agencies and military bases involved in pesticide usage have been contacted and most have provided considerable insights into current pesticide use on Guam.

The military is unable to supply exact information about environmental contaminants in the form of chemical types, concentrations, areas and frequency of applications before 1975. A few general reports indicate widespread use of DDT up to the time of its removal from the general market but no quantitative information could be obtained.

Other private and government agencies were able to supply only chemical names, recommended concentrations, and relative frequency of use. Brewer Chemical, the island's sole private distributor of pesticides and herbicides, keeps careful records of the amount of chemicals imported and distributed on Guam. Approximate extrapolations may be made for each year, using Department of Agriculture's recommended concentrations, however, areas of application can only be roughly approximated.

It appears that any program involving the impact of pesticides can expect to deal with chemicals applied only over the last five years or chemicals that contaminate the environment for a long period of time (chlorinated hydrocarbons). Emphasis has been placed on a research program dealing with analysis of birds' body tissues and stomach contents to determine if any level of pesticide contamination exists.

The Patuxent Wildlife Research Center has been contacted for assistance in developing this study, and preliminary plans for pesticide analyses has been drawn up. A minimum of destructive sampling is planned using Micronesian starlings (Guam's most abundant native forest bird) and black drongos (a common introduced insectivore). Food samples for analysis will be obtained from a wide range of living birds through a non-destructive expectorant technique. Although plans are for a Patuxent biologist to travel to Guam to coordinate initial data collection, actual analysis will be performed at Patuxent's lab in Maryland. Because current plans are to fund this research program through our Section 6 Endangered Species Cooperative Agreement, the implementation of pesticide sampling and analysis has been given inactive status for Segment 18.

RECOMMENDATIONS

1. Continue collection and compilation of historical information on the use of pesticide and herbicides.

2. List this Job as inactive for Guam's FW-2R-18 Project Agreement, pending funding for research and analysis through our Section 6 Endangered Species Cooperative Agreement.

3. Prepare a final report dealing with the impact of environmental contaminants on Guam's wildlife and any control measures that need to be employed.

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Report Prepared by Anne F. Maben

Guam broadbill

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-17
SUB-PROJECT NO.: W-5
STUDY NO.: 7
JOB NO.: 2

JOB TITLE; Implementation of Pesticide Sampling and Analysis

PERIOD COVERED: October 1, 1979 to September 30, 1980

OBJECTIVES

To implement a program of sample collection and analysis for pesticide residues.

RESULTS

This job was inactive during this segment pending development of a sampling program under Job W5-7-1.

RECOMMENDATIONS

This job should be implemented in Segment 18 if adequate manpower is available.

Report Prepared by Robert D. Anderson

Guam Wildlife Development
Project W-4-D-1

Federal Aid in Wildlife Restoration Act

Sub-project WD-1	Development of Conservation Lands for Wildlife Management, Public Hunting, and Recreation

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-4-D-1
SUB-PROJECT NO.: WD-1

SUB-PROJECT TITLE: Development of Conservation Lands for Wildlife Management, Public Hunting, and Recreation

PERIOD COVERED: October 1, 1979 through December 31, 1980

SUMMARY

This sub-project has been inactive during this segment.

BACKGROUND

The Government of Guam has established four Conservation Areas, totaling over 5,000 acres, to be managed for wildlife conservation and to be available to the public for hunting and other recreational uses. Though these areas have existed for several years, they are little used by the public because of a general lack of access. The lack of access has also been a major obstacle to the implementation of proper management of the wildlife and wildlife habitat of the Conservation Areas.

Most hunting activity on Guam currently occurs on the military lands on the northern third of the island. Because of the nature of these lands and the security restrictions imposed by the military, only a limited number of hunters can be accommodated. As the population of Guam grows and more leisure time becomes available to the populace, the hunting pressure may become so great that the military land alone cannot meet the demand. Also, the wildlife populations on military lands are a limited resource that cannot be expected to provide for the total projected future hunting demand.

The problem is to develop adequate access to these conservation areas to allow for the implementation of biologically sound management of the wildlife and wildlife habitat in the areas as well as to provide the opportunity for public hunting and other recreational use of the conservation reserves. Because of its size and potential for management and recreational use, including hunting, the prime emphasis is on development of the Bolanos Conservation Area.

Some background work in this regard has been completed, including a registered survey of Bolanos, dated 1972, and a proposed access road route from the NASA tracking station in Dandan.

Recent developments include a legislated change in jurisdiction over Conservation Areas and the inclusion of both the Bolanos and cross

Island Conservation Areas in the proposed Territorial Seashore Park. Public Law 12-209, passed by the 12th Guam Legislature in 1974, repealed that section of the Government Code giving the Department of Agriculture jurisdiction over Conservation Areas. Jurisdiction over these areas was transferred to the Department of Parks and Recreation, though management responsibilities for wildlife remain with the Department of Agriculture.

Because of this jurisdictional change, and the fact that both the Bolanos and Cross Island Road Conservation Areas have been included in the Territorial Seashore Park being developed by the Department of Parks and Recreation, the planning and implementation of any access development project must be a joint venture. A Territorial Seashore Park Management Committee has been established, consisting of the Departments of Parks and Recreation, Agriculture, Land Management, the Bureau of Planning, and the Guam Environmental Protection Agency. As a member of this Committee, we maintain close liaison with the Department of Parks and Recreation regarding the development of park, and work closely with them in designing and implementing our access development project. We believe that close cooperation is necessary to ensure that the development of the Seashore Park is compatible with the original intent of the Conservation Areas and to ensure the protection and wise management of the wildlife resources in these areas.

OBJECTIVE

The objectives of this development project are to provide adequate access to designated conservation areas in order that management of the wildlife resource be efficiently conducted and public access for hunting and other recreational uses be assured.

RESULTS

This sub-project has been inactive during this segment due to continuing uncertainty about the status of the Territorial Seashore Park its real development needs. The Division has actively participated as a member of the Territorial Seashore Park Management Committee.

RECOMMENDATIONS

Place this sub-project in inactive status pending resolution of the status of the Territorial Seashore Park and re-evaluation of the real need for public access to this area. Continue to support the Seashore Park through active participation on the Management Committee.

Report Prepared by Robert D. Anderson

Guam Wildlife Development
Project W-4-D-1

Federal Aid in Wildlife Restoration Act

Sub-project WD-2 Development of Office, Laboratory and Animal-holding Facilities

JOB PROGRESS REPORT
DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-4-D-1
SUB-PROJECT No.: WD-2

SUB-PROJECT TITLE: Development of Office, Laboratory and Animal Holding Facilities

PERIOD COVERED: October 1, 1979 through December 31, 1980

SUMMARY

The tentative design, scope of work, and contract package for construction of the office building have been nearly completed by the Department of Public Works and should be let out for bid in early 1981. Renovation of the laboratory facility has been inactive pending completion of the office building.

BACKGROUND

The Division of Aquatic and Wildlife Resources has been housed in the same 1463 sq. ft. office space since the Division was created in 1961. Since that time, the staff has increased greatly to its present size and the manpower requirements of the Division are expected to continue to grow. The Division is now involved with several Coastal Zone Management programs and will soon be actively conducting endangered species programs funded through our Section 6 Cooperative Agreement. These programs require additional staff members that must be housed somewhere.

The current situation allows for very cramped office space, with the attendant noise, confusion and unorderliness that results when too many people, desks, and materials are crowded together. There is inadequate storage space, inadequate working space for the use of maps, aerial photographs, or report collation and layout, and no laboratory facilities whatsoever.

The current cramped quarters occupied by the Division are responsible for a reduction in morale and efficiency, and are the prime constraint on the growth of our staff and our management and research programs. The growth necessary to meet our increasing responsibilities cannot take place until adequate facilities are available.

New office space is greatly needed to allow for the expansion of the Division staff to meet its increasing responsibilities. Adequate space for desks, working areas, and storage must be acquired before any new programs can be implemented or needed staff added.

In addition to office space there is a great need for laboratory facilities. The space formerly used by the Division for laboratory space slowly was converted into desk space to accommodate past staff increases, and consequently there is no laboratory space available. As the Wildlife Section extends its emphasis beyond survey and inventory work and begins to conduct true research projects, there will be an increasing need for laboratory space. Planned projects include studies of predation, pesticides, food habits, and movement of several wildlife species. Laboratory facilities will be required to do needed autopsy work, stomach and fecal content analysis, specimen preparation and storage, etc. Both laboratory and shop facilities will be necessary for the design, fabrication and maintenance of radio-telemetry equipment used in studies of movement and home-range. Darkroom facilities will be necessary for report preparation and will be valuable in numerous research activities.

It is anticipated that animal holding facilities will be needed as part of the laboratory, in order that fruit bats, birds, and other animals involved in research projects be housed. Planned fruit bat research will require maintaining some fruit bats in captivity for varying periods of time for the purposes of developing handling, tagging and marking; and radio-instrumentation techniques. Reproductive studies are anticipated that may require the captive maintenance of fruit bats, and captive bats may also be needed for certain studies of food habits and preferences.

There is also a need for facilities in which birds could be housed for varying periods. In several cases there has been a need for facilities in which to house and nurse injured birds. Also, certain anticipated studies on several bird species may require the maintenance of limited numbers in captivity, as described for fruit bats.

OBJECTIVE

To provide adequate office and laboratory facilities to allow for necessary increases in staff and planned expansion of the Wildlife Section's research program.

PROCEDURES

1. New office facilities will be acquired by having an appropriately sized concrete building designed and constructed. The building will be erected at the Department of Agriculture near the present office of the Division of Aquatic and Wildlife Resources. The new office facility will be used by staff of the Wildlife Section.

2. Laboratory, darkroom, and animal-holding facilities will be acquired by remodeling the existing soils lab building at the Department of Agriculture. This concrete building is currently unused and can be renovated to provide the needed facilities at relatively little expense. The completed facility will include storage space, laboratory facilities, and an outdoor flight cage for birds and fruit bats. This facility will be used primarily by the Wildlife Section.

RESULTS

The Department of Public Works has been retained as contract administrator to oversee the design and construction of the office building. They have completed the tentative design and scope of work, and are in the final stages of preparing the contract package for bid. The contract should be awarded and construction started early in 1981, with completion of the office by mid-year.

The original plan was to construct a modular-type wooden structure. Because of recent changes in construction costs on Guam and upon the advice of Public Works, we have changed the plans and now are having a 30'x45' concrete building constructed. Costs of a wooden modular building are now nearly the same as concrete construction and the concrete structure will have a much longer life and lower maintenance cost.

The renovation of the laboratory building has been inactive pending completion of the office facility.

RECOMMENDATIONS

Begin the renovation of the laboratory facility as soon as funds are available.

Report Prepared by Robert D. Anderson

Conservation Education Program

Period Covered: December 15, 1979 to
August 20, 1980

Through a grant from Coastal Zone Management, the Division was able to hire a Public Information Officer to design and carry out a public awareness/conservation education program.

The Public Information Officer worked toward developing and implementing a conservation education program geared to helping the people of Guam develop a conservation ethic and an appreciation of the value of natural resources. He worked closely with local radio, television and print media, University of Guam Cooperative Extension Service and with the public-at-large. Methods of contact included slide presentations, public appearances on radio, TV, in classrooms and organizational meetings, printed materials including popular articles, brochures, posters and other printed materials. Specific topics addressed were:

(a) Familiarization of the public with Guam's wildlife resources, their natural history and the status of ongoing research efforts;

(b) The cultural and historical values of Guam's fish and wildlife resources;

(c) The causes of the decline of Guam's wildlife resources, including habitat loss, exploitation, pollution, and other factors;

(d) The need to protect endangered species and the development of public support for the extension of such protection to native species of Guam;

(e) The need to protect and manage fish and game species, and the development of public familiarity and respect for the protective laws and regulations;

(f) The systems approach to natural resource management. The relation of wildlife and fisheries management to the management of other resources.

Major projects completed under this program include:

(a) The production of a slide/tape program on the Coral Reef suitable for elementary school children. One side of the tape is in Chamorro for use in the Chamorro Language Program.

(b) Printing of 4,000 sets of wildlife flyers (20 flyers to a set) depicting the habits of major Guam animals complete with a high quality full color photograph of each depicted species.

(c) Conducting of a one week Environmental Workshop "Wet and Wild" attended by 50 island teachers and conducted by Don Kellogg and Jane Burris, off-island Consultants.

(d) Production of 500 two-color "Poaching" posters.

(e) Production of two-color fishing regulation handouts.

Recommendations:

(a) A set of 24 additional full color wildlife flyers to include all endangered species should be produced.

(b) Television and radio public service announcements should be utilized to a greater extent.

(c) An advanced Coral Reef script should be written to accompany the film strip to be distributed to secondary schools.

(d) Production of additional slide programs.

(e) Printing of coloring book/activity guide for elementary aged school children.

Prepared by: JUDY E. BEAVER

LAW ENFORCEMENT SECTION

Between October 1, 1979 and September 30, 1980, fifteen (15) separate illegal hunting cases resulted in the arrest of thirty-nine (39) individuals. One illegal fishing case (fishing with explosives) resulted in the arrest of four (4) persons.

Incidents which didn't result in arrest were also recorded. There were forty-six (46) written incident reports regarding hunting violations and nine (9) reports of illegal fishing. The most common violations include hunting with artificial lights, hunting out of season, fishing with explosives and toxic chemicals, and fishing with small-mesh nets.

The Division received a grant from the Guam Coastal Management Program, administered by the Bureau of Planning, for the recruitment of a limited-term Conservation Officer and the purchase of much needed equipment, including a new vehicle and several radios.

Report prepared by: Charles R. Bonds

Explosives used in illegal fishing

Fruit bat shot by poachers